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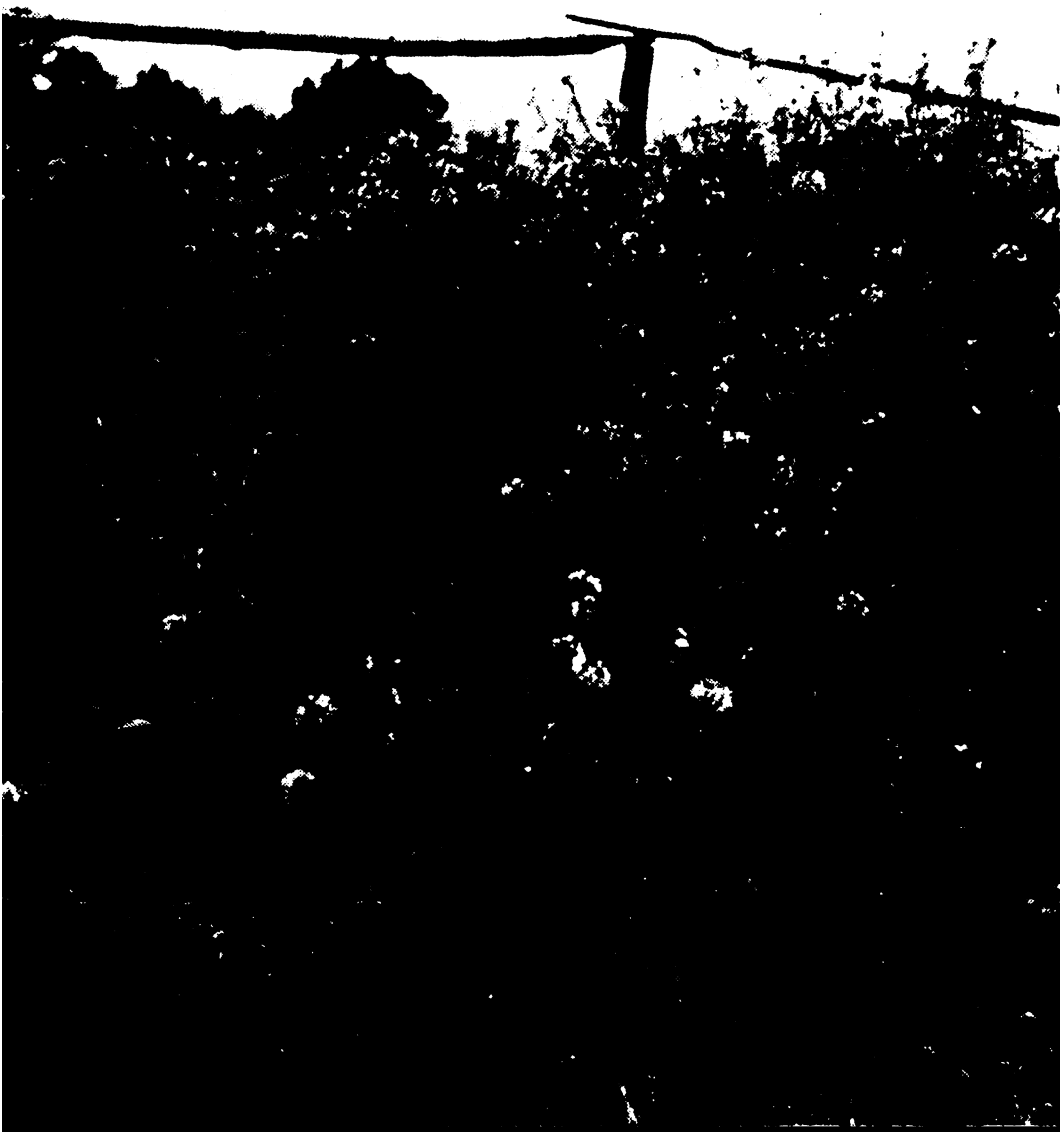
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*The Proceedings of the Iowa
Academy of Science*

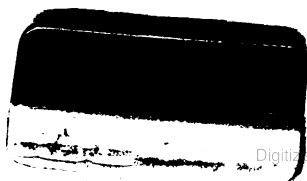
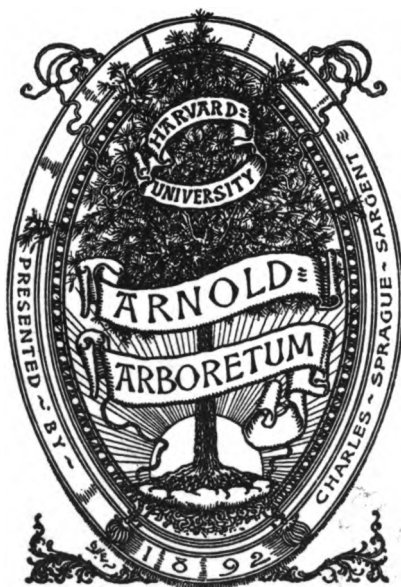
Iowa Academy of Science

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PROCEEDINGS

OF THE

Iowa Academy of Science

FOR 1910

VOLUME XVII

EDITED BY THE SECRETARY

PUBLISHED BY THE STATE

DES MOINES:
EMORY H. ENGLISH, STATE PRINTER
1910

LETTER OF TRANSMITTAL.

DES MOINES, IOWA, July 1, 1910.

To His Excellency, Beryl F. Carroll, Governor of Iowa:

In accordance with the provisions of title 2, chapter 5, section 136, code, 1897, I have the honor to transmit herewith the proceedings of the twenty-fourth annual session of the Iowa Academy of Science and request that you order the same to be printed.

Respectfully submitted,

L. S. Ross,
Secretary Iowa Academy of Science.

IOWA ACADEMY OF SCIENCE

v

OFFICERS OF THE ACADEMY.

1909.

President—FRANK F. ALMY.

First Vice-President—G. L. HOUSER.

Second Vice-President—A. C. PAGE.

Secretary—L. S. ROSS.

Treasurer—GEORGE F. KAY.

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Elective—SAMUEL CALVIN, N. KNIGHT, C. O. BATES.

1910.

President—G. L. HOUSER.

First Vice-President—L. BEGEMAN.

Second Vice-President—A. A. BENNETT.

Secretary—L. S. ROSS.

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Ex-officio—G. L. HOUSER, L. BEGEMAN, A. A. BENNETT, L. S. ROSS, G. F. KAY.

Elective—GUY WEST WILSON, C. N. KINNEY, H. S. CONARD.

PAST PRESIDENTS.

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NUTTING, C. C.	1890-92
PAMMEL, L. H.	1893
ANDREWS, L. W.	1894
NORRIS, H. W.	1895
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FRANKIN, W. S.	1897
MACBRIDE, T. H.	1897-98
HENDRIXSON, W. S.	1899
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VEBLEN, A. A.	1901
SUMMERS, H. E.	1902
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SHIMEK, B.	1904
AREY, M. F.	1905
BATES, C. O.	1906
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TODD, J. E.	Lawrence, Kan.
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UDDER, J. A.	Rock Island, Ill.
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WINSLOW, ARTHUR.	Kansas City, Mo.
YOUTZ, L. A.	New York City, N. Y.

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PROCEEDINGS OF THE Twenty-Third Annual Session of the Iowa Academy of Science

The meeting of the twenty-fourth annual session of the Iowa Academy of Science was held in the Zoological Lecture Room, Blair Hall, Iowa College, Grinnell, on Friday and Saturday, April 29 and 30, 1910.

In the business meetings the following matters of general interest were presented:

REPORT OF THE SECRETARY.

To the Members of the Iowa Academy of Science:

One portion of the secretary's report has become monotonous; that is, that the publication of the proceedings has been delayed. And it has not been entirely the fault of the secretary. Things have seemed to conspire against the printing of the proceedings; even the United States government, in that the postal service failed to deliver some of the galley proof entrusted to its care. Beset with delays here; and misplaced cuts there, the secretary humbly apologizes for his own short comings, and promises he will attempt to induce others to recognize and to correct the error of their way.

For a short time this spring it seemed that it would be advisable to propose an amendment to the constitution to the effect that a third vice-president should be added to the list of officials. The president of the Academy has been in Columbia University all year, and consequently it was not practicable for him to preside at the annual meeting. The first vice president found it would not be at all convenient for him to attend. The second vice president with due modesty accepted the honor

thus falling upon him, and it seemed certain we were to have a presiding officer. Then, a few weeks ago a letter was received from him stating that circumstances had arisen making it impossible for him to be in attendance. When the condition of affairs was presented to the first vice president he said he would attend whether it were convenient or not. But instead of all three of these officials preparing presidential addresses, neither one of the three did. As a result the Academy must depart from custom this year and forego the usual address.

The membership of the Academy should be increased. The Illinois Academy, which was organized only a year or two ago, has a large membership. The Iowa Academy should enroll many of the high school science teachers. The large majority of our active members are college instructors and advanced college students. Since the science teachers in the high school do not have as long a tenure of office on the average as the college instructor, we cannot expect as large a number proportionally from their ranks as from the colleges. But there should be more of them with us. Suggestion from the college professor to the graduates in science, that they identify themselves with some scientific society would be conducive of good results. Personal work will add names to our roll.

In looking at a program of the Academy, it is at once evident that many sciences are represented by the active workers. There is no indication of concerted action among members in scientific research. Usually every title is entirely distinct from every other one; it is a subject standing out by itself. Such broadness and comprehensiveness in the work is in accord with the purpose of the Academy. Yet the query arises whether or not it would be a good plan to do some continuous work on state problems, the work being done by groups of those whose interests are similar. We have an effective Geological Survey. Work is being done scientifically and in order. Would it be feasible for a group of investigators to voluntarily work together, each in his own locality, upon some phase of a problem that would naturally fall to them? The botanists, chemists, and zoologists might institute surveys of the state. "You in your small corner and me in mine." Last year a letter was received from a member of the Academy, asking if there be any concerted action by committees upon assigned topics. Some years ago such committees were in existence, but not in recent time. In Vol. IV of the proceedings, there is an article on the Illinois Biological Station, in which the author raises the query as to the possibility of co-operation among the colleges of the state for the establishment of a laboratory for the study of the fauna and flora. That is probably not feasible, nor is there such need

since the establishment of the State University Laboratory at Lake Okoboji. But is it not possible for us to spend some time at our own laboratories on the same or on correlated topics, and in time attain to a more comprehensive view of the natural history of the state.

Respectfully submitted,

L. S. ROSS, Secretary.

PROGRAM OF THE IOWA ACADEMY OF SCIENCE.

The sessions of the Academy were held in the Zoological Lecture Room in Blair Hall, Iowa College, Grinnell, beginning at 1:30 p. m., Friday, April 29th.

The public address by Professor William A. Noyes of the University of Illinois, on "A Scientific Revolution," was given Friday at 8:00 p. m., in the College Chapel.

1. The Digestibility of Bleached Flour.....E. W. Rockwood
2. The Effect of Continued Grinding on Water of Crystallization.....
..... Nicholas Knight
3. A Study in the Determination of Calcium.....George W. Heise
(Introduction by W. S. Hendrixson.)
4. A Notice on the Cast Iron Casing in Well 4 at Grinnell.W. S. Hendrixson
5. The Iowa Lakeside Laboratory—Illustrated R. B. Wylie
6. The Flower of Elodea—Illustrated R. B. Wylie
7. Preliminary List of the Parasitic Fungi of Fayette County, Iowa...
.....Guy West Wilson
8. Prairie Openings in the Forest.....B. Shimek
9. The Influence of Air-Currents on Transpiration.....Miss Maud A. Brown
(Introduced by B. Shimek.)
10. Delayed Germination L. H. Pammel and Charlotte M. King
11. The Problem of Weeds in the West.....L. H. Pammel
12. Spore Formation in *Lycogala Exiguum*.....Henry S. Conard
13. Some Geological Aspects of Artificial Drainage.....G. G. Wheat
14. The Pleistocene Record of the Simpson College Well.....John L. Tilton
15. The Aftonian Age of the Aftonian Mammalian Fauna.....Samuel Calvin
16. Some Standardizing Tests of Stern's Tone Variator.....R. H. Sylvester
(Introduced by C. E. Seashore.)
17. Discrimination Sensibility for Pitch Within the Tonal Range.....
.....H. G. Schaefer
(Introduced by C. E. Seashore.)
18. The Technique of Pitch Discrimination Measurements.....C. E. Seashore
19. Some Recent Discoveries Concerning Behavior of Platinum-Iridium
Wires Lee P. Sieg
(Introduced by A. G. Smith.)
20. Concerning a Study of Kerosene Oils by Physical Methods..G. W. Stewart
(Introduced by A. G. Smith.)
21. Historical Sketch of Early Health Regulations in Iowa.....L. S. Ross

- ## REPORT OF THE COMMITTEE ON MEMBERSHIP.

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By virtue of the fact that there is now a general movement for the conservation of our natural resources, both by the national authorities and more recently by the state, therefore be it

Resolved, That the Iowa Academy of Science in session hereby reaffirm its endorsement of the general movement toward the conservation of our forests, rivers, lakes and mineral resources by the national government.

Resolved, That the Academy wishes further, to voice its approval of the work already begun by our own state through its State Geological Survey and Conservation Board, and urge upon our state authorities the desirability of confirming and extending the work already begun by these.

In consideration of the courtesies shown the members of the Iowa Academy of Science in connection with the 1910 meeting at Grinnell, Iowa, therefore

Resolved, That the Academy hereby express its appreciation of the hospitality of Grinnell, and extend thanks to Grinnell College, the local committee of the Academy, the Alumni Association of the College, and other citizens of Grinnell who have by their interest and efforts contributed to the success of the present session of the Academy.

(Signed) GUY WEST WILSON,
HARRY KELLY,
ROBERT B. WYLIE,
Committee.

NAMES OF THOSE IN ATTENDANCE.

Florence A. Adams; C. O. Bates; Maud A. Brown; J. A. Baker; Margaret Buckley; O. E. Buckley; H. S. Conard; E. Louise Douglass; Wesley Greene; J. E. Guthrie; Frederic A. Harvey; G. W. Heise; W. S. Hendrixson; Charles W. Hungerford; E. A. Jenner; G. F. Kay; Harry M. Kelly; C. N. Kinney; Adelbert L. Leathers; James H. Lees; H. W. Norris; L. H. Pammel; Ruth Patridge; Mrs. Gertrude B. Phillips; D. W. Rosencrans; L. S. Ross; H. G. Schaefer; B. Shimek; L. P. Sieg; Arthur G. Smith; G. W. Stewart; H. E. Summers; R. H. Sylvester; John L. Tilton; G. G. Wheat; Guy West Wilson; R. B. Wylie.

AMENDMENT TO THE CONSTITUTION.

The following proposed amendment was presented in due form and was adopted: In section 4, insert after the words, "required of each fellow" the words, "and \$1 of each member."

IOWA ACADEMY OF SCIENCE

TREASURER'S REPORT.

RECEIPTS.

Cash on hand, April 29, 1909.....	\$200.85
Dues and Initiation Fees, 1909-1910.....	147.00
Sale of Proceedings, etc.....	5.44
Interest on Deposits	7.84

\$361.13

EXPENDITURES.

Expense of Lecture 23d Meeting.....	\$ 23.00
Binding, reprints, mailing, Proceedings of 22d Meeting.....	95.50
Postage, typewriting, and incidental expenses of Secretary.....	12.40
Honorarium of Secretary, 1909-1910.....	25.00
Postage and receipts for Treasurer.....	4.50
Cash on hand, April 29, 1910.....	200.73

\$361.13

Respectfully submitted,

GEORGE F. KAY.

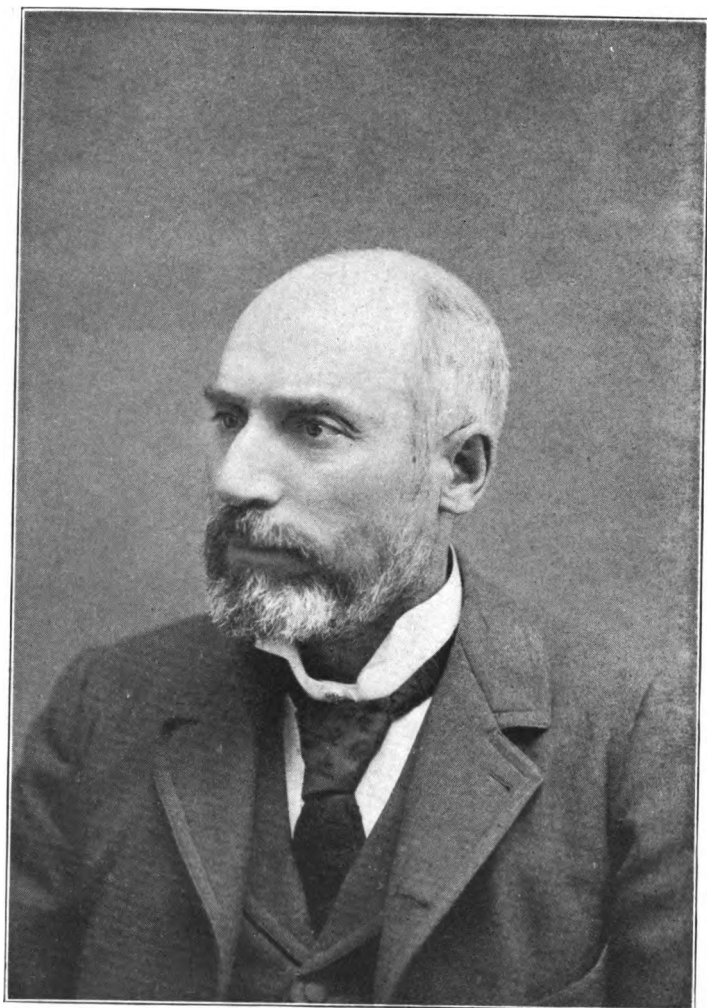
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First Vice-President	L. Begeman
Second Vice-President	A. A. Bennett
Secretary	L. S. Ross
Treasurer	George F. Kay

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Ex-officio: Gilbert L. Houser, L. Begeman, A. A. Bennett, L. S. Ross, George F. Kay.

Elective: Guy West Wilson, C. N. Kinney, H. S. Conard.



FINLEY M. WITTER.

NECROLOGY.

FINLEY M. WITTER.

The death of Professor Finley M. Witter at Biloxi, Mississippi, October 29, 1909, removed from earthly activities a charter member, a former president, and an honorary life member of this Academy.

He had removed to Mississippi to be with his son and daughters for a time, but at the time of his death he was planning to return to this State and to continue his activities in the old familiar field.

Professor Witter was born in St. Joseph, Indiana, August 15, 1839, and removed to Iowa with his parents in 1850. The hardships of pioneer days which he endured both here and in the far west no doubt strongly reinforced and developed his naturally kindly, sympathetic and unselfish nature which made of his life a life of service to his fellowmen.

He graduated from the Normal department of the State University of Iowa in 1861, received the degree of B. S. in 1869 and that of M. A. in 1875, and in 1906 was elected to honorary membership in Iowa Chapter of the Sigma Xi. He organized the schools of Muscatine, Iowa, in 1864, establishing the high school, and was elected its principal and superintendent of the city schools. Forty-eight years of his life were devoted to the schools of Muscatine and of Muscatine county. The greater part of this time was given to general educational activities, and he was an active member of the National Educational Association and of the Iowa State Teachers' Association.

Notwithstanding his devotion to his scholastic duties, he found time to do meritorious scientific work. He entered upon this work early, and was one of the pioneers in this field in the state. He found in the natural history of Muscatine county a field of unusual richness and it was his privilege to make much of it known to the scientific world. Unfortunately his most extensive manuscripts, describing the Lepidoptera and birds of Muscatine county, together with the greater part of his collections, were destroyed in the Muscatine High School fire in 1895, a calamity which almost broke his spirit. Nevertheless he has left a record of work which no student of the natural history of the state can disregard in the future.

In common with all naturalists of his earlier days he covered a broad field, but into every department of the work he carried the same energy and keenness of vision, and no one who ever accompanied him to the field could ever forget the infectious, almost boyish enthusiasm and deep affection which inspired him.

His work in botany was merged with that of his friend and associate of many years, the late Ferdinand Reppert, with whom he was engaged in study and field work both in Muscatine county and in the Rocky Mountains, but in the last years of his life his interest centered in this field and it was his intention to devote himself to it exclusively.

His earlier work covered a wide field. He studied the geology of Muscatine county, and his reports upon the loess, then but little known in this state, are of special interest and value. In connection with his loess investigation he took up the study of the local land and fresh-water mollusks and was in his day the only student of the loess problem who was familiar with the species which constitute the chief fauna of the loess. His two most extensive papers dealt with this subject. The "List of Shells of Iowa" was published in 1878 in the *British Quarterly Journal of Conchology*, Vol. I, and "The Mollusca of Muscatine county and Vicinity" appeared in 1883. These were the first published annotated and descriptive lists of Iowa mollusks, and the latter contained the most complete list of Iowa loess fossils which had been published up to that time.

Prof. Witter's work in the interest of this Academy is well known to the older members. He was an active member of the old Academy of Sciences throughout almost its entire existence, having been elected at its first meeting. He was a charter member of the present Academy, its president in 1889 and 1890, and for several years a member of the Executive Committee. In recognition of his services he was made an honorary life member at the Cedar Falls meeting in 1908. Some conception of his activity may be gained from the following list of titles of papers published in full or in abstract form, in the Proceedings of the Academy:

In the Proceedings of the Iowa Academy of Sciences for 1875-80, published in 1880:

Notes on Land and Fresh Water Shells at Muscatine, p. 8.

Observations on the Genus *Limnea*, p. 15.

Some Geological Features near Muscatine, p. 16.

The Cabbage Butterfly, p. 21.

On the Number of Hours Children May be Confined in the School-room Each Day, p. 22.

On the Occurrence of Certain Shells in the Vicinity of Muscatine, p. 23.

In the Proceedings of the present Iowa Academy of Sciences: Volume I, Part 1, published in 1890:

Notes on Some Shells and Ferns, p. 17.

Some Additional Observations on the Loess in and about Muscatine, p. 45.

The Ferns of Muscatine county, Iowa, p. 96.

Part II, published in 1892:

Notice of Arrow points from the Loess in the city of Muscatine, p. 66.

The Gas Wells near Letts, Iowa, p. 68.

Part III, published in 1893:

Some Observations on *Helix cooperi*, p. 28.

On the Absence of Ferns between Fort Collins and Meeker, Colorado, p. 29.

Notice of a stone Implement from Mercer county, Illinois, and one from Louisa county, Iowa, p. 30.

Volume VI, 1899:

Observations on the Geology of Steamboat Springs, Colorado, p. 93.

Professor Witter's work was seriously interrupted and much of it wholly destroyed by fire in 1895, but fortunately a large collection of mollusks, including the loess fossils, was safe at his home. About two years before his death, having given up all thought of work other than that in botany, he presented this collection to the chairman of your committee, together with his field notes. He also pointed out, in a series of field excursions, the exact localities in which he collected his loess fossils, and gave much other interesting information, all of which will be considered in reports on the loess in the near future.

In view of the fact that the aeolian origin of loess is now generally conceded it is of interest to note that as a result of his comparative studies of recent and loess mollusks Professor Witter long questioned the adequacy of the aqueous theory, and as early as 1880 ventured to express some doubt in a paper "On the Occurrence of Certain Shells in the Vicinity of Muscatine," at a time when the aqueous theory held full sway.

While much of Professor Witter's work was of real scientific value, he excelled particularly in arousing the interest of children and of the general public in the natural history of his vicinity. He published numerous articles on local natural history in the Muscatine papers, stimulated the pupils of the schools to study the world about them, and by his energy and enthusiasm was able to sustain the Muscatine Academy of Sciences for several years. He was a true lover of nature, for his was a heart so great in its affections that it could include not only the members of the human race, but all the living world about him.

By his death this Academy has lost a valued and honored member, the State of Iowa a most useful citizen, and the children of the state a friend

than whom none could ever be more earnest and sincere. With his bereaved widow and family we share the burden of the great sorrow which has overwhelmed them.

B. SHIMEK,
L. H. PAMMEL,

PAPERS PRESENTED

AT THE MEETING OF 1910

THE INFLUENCE OF AIR-CURRENTS ON TRANSPIRATION.

BY MAUD A. BROWN.

This is intended merely as a brief preliminary report on experiments now under way to show the influence of air-currents on transpiration. They have arisen from a study of transpiration in general, during which the conviction has grown that one very important factor has been largely neglected. Therefore this has been made the main point of attack while side lines of investigation have been carried on in which it has been attempted to vary one factor at a time, i. e., light, temperature and humidity, and to determine if possible the relative influence of each on transpiration, and their importance as compared with that of air-currents. They are not complete, but so far, they indicate that humidity of the air is the most important of the three mentioned.

These experiments have been carried on in doors, because of the possibility of controlling conditions. The air-currents were produced by an electric fan, different velocities being secured by placing the plants at varying distances from the fan.

Elongated boxes, open at both ends, 15x18 inches by 3½ feet, were used, one end of glass, that the light problem might be eliminated. The fan was set in the dark end, the plant in the light, and at varying distances in front.

The wind velocities at these stations were determined by a small mill anemometer, the humidity and temperature by Green's standard psychrometer, and the air pressure by an aneroid barometer.

The plant selected was *Clivea*, one of the *Amoryllidaceae*. It has the advantage of having long stiff leaves, which will stand erect under the current, so that no stems need be used, the whole surface being transpiring surface. The epidermis is easily removed and the stomata are of good size. Leaves of as nearly as possible the same age were used and sealed into slits in the corks of wide mouthed bottles.

Four stations were established. I. 1½ feet in front of fan, wind velocity 800 feet per minute. II. 3½ feet in front of fan, wind velocity 300. III. 7 feet in front of fan, wind velocity 205. The fourth station in quiet air of the laboratory.

The psychrometric and barometric readings showed little variation in air pressure, and humidity. The leaves were cut off even with the cork at the end of each experiment and weighed.

The results show (1) That in every case of plants exposed to the strongest current, a checking of transpiration occurred. (2) That the plants at the two middle stations showed greatest loss of water, while from the plant in quiet air, less was given off.

Even when the strongest current caused complete wilting (as it did in several plants, i. e., geranium, box elder, etc., before *Clivea* was hit upon) the loss of water was little, or none.

The stomata of the *Clivea* have not been examined under the conditions of the experiment, but the geranium used at first showed the guard cells greatly disturbed, but not consistently so, on one leaf some being closed, some open and some in intermediate stages.

As an example of the results obtained—one table shows as a total of observations taken every two hours during one day:

Station 1.	.5 gr. wt. of leaf	19.6,
Station II.	.7 gr. wt. of leaf	16.6,
Station III.	.11 gr. wt. of leaf	14.2,
Station IV.	(Quiet.) .55 gr. wt. of leaf	13.3.

Another series—reading taken at intervals of $1\frac{1}{2}$ hours during a day and a half (night reading being eliminated on account of a fall of temperature which could not be recorded.)

Station I.	1.2 gr. wt. of leaf	19 gr.
Station II.	2.3 gr. leaf wt.	14.5,
Station III.	(Quiet). .4 gr. leaf wt.	10.4.

The results of the experiments thus far carried out indicate that air-currents of greater velocity check, while gentler currents stimulate transpiration.

A number of interesting incidental observations were made. For example, one which showed a structural difference developed by difference in environment as regards light and air.

In one end of the plant house the geraniums brought in from the grounds last fall were cut back and set out crowded very closely. The leaves they bear now were developed under the plant house conditions. Two leaves from each of six plants were examined, one from the top, exposed freely to light and air, the other from underneath, shut away from air-currents and with reduced light. In every case the exposed leaf was found to have fewer and much larger guard cells with much wider stomata. (Lloyd's method of fixing stomata being used in all the observations on stomata.)

Along the same line, Pisch evaporimeter readings were taken at two stations in the plant house: I. beside a geranium exposed all round to light and air, and II. suspended among the branches of the densely crowded plants, about 2 feet distant. The evaporimeter readings for six days being as follows:

Station I. 4.7 hundredths of cu. in., 7.5, 11.0, 14, 17.5, 20.

Station II. 4.5, 5.0, 7.0, 7.2, 9.2, 10.

Stomata were examined from leaves near the two instruments, and the same difference noted above appeared, i. e., the leaves on the plant in the exposed situation showed large guard cells and stomata more widely distended, those from the crowded one showed many and small guard cells.

PRAIRIE OPENINGS IN THE FOREST.

BY B. SHIMEK.

Treeless openings in otherwise forested areas have long been known to field-workers in this part of the Mississippi valley. These openings are striking because of the absence of trees, but their flora differs also from the minor flora of the forest, being in fact the typical flora of the drier prairies. It matters not how remote the greater prairie areas may be, or how completely these openings may be surrounded by forest, their flora is invariably of the same general prairie type.

They are exceedingly variable in extent. Sometimes they have an area of only a few square rods, as is (or was) the case in the more heavily timbered parts of the state; again they are mere tongues of the general prairie and naturally blend with it, as in the rougher western parts of the state.

They differ in the nature of their soil. In the northeastern part of the state they occur on the driftless surfaces whether covered with loess or geest; they are equally present on all the types of drift sub-soils from the Kansan to the Wisconsin; they are well-developed on all kinds of loess surfaces; and they are common on sandy and alluvial areas.

But whatever may be the differences between them they agree in occurring uniformly on the rougher surfaces of the state, and they have the same flora.

The naturally timbered areas of the state are rough, and the prairie openings are more or less distinctly contrasted with the forest. Sometimes, especially where there are abrupt changes in topography, the line between the prairie openings and the forest is sharp; again the two types blend and a scant sprinkling of trees, usually stunted hard-wood species such as oaks, etc., encroaches upon the prairie border producing the typical "oak-openings" or "oak-barrens." Their distribution suggests that this rough topography accounts for their existence, for they occur uniformly on surfaces which are exposed to the two great factors which determine evaporation—namely, the sun and wind. They are therefore usually located on the very tops of the ridges, or on the south-

westerly slopes where they receive the full effects of the "two-o'clock sun" and our prevailing southwesterly summer winds. Sometimes where a ridge slopes gradually to the north these openings will follow it on that side for some distance, such slopes being but little sheltered from both wind and sun. Sometimes other slopes than those on the south and west are treeless, but in such cases local topography produces a persistent change in the direction of the air-currents, or the slopes are merely a part of a greater dessicated area.

These limited openings therefore owe their existence to the same causes which have produced our broader prairies, and must be regarded as prairie types.

So great is the difference between the flora of these openings and the smaller flora of the surrounding forest, that frequently in the more heavily forested sections of the eastern part of the state not a single species of either flora is mingled with the other. The difference is evidently due to the fact that the minor flora of the forest is mesophytic, while the prairie flora is essentially xerophytic and can persist in exposed situations where the former would fail. The writer has made extensive detailed comparisons of the flora of various prairie areas,* including the prairie openings, and has found the flora practically the same. There are variations in the lists of species which may be found in the prairie openings of even the same forested regions, but these differences are not greater than those which will be observed in different parts of the same larger prairie area of the ordinary type, and they take place within the same limits.

In order that this fact may be brought out more prominently a list of the plants which the writer has collected in typical prairie openings in the eastern part of the state, chiefly in Johnson county, is here included.

It will be observed that the plants belong without exception to the flora of the broader prairies. The relative abundance and distribution of the species is also the same. It should be noted that the list includes only those species which are now found in the herbarium of the State University. For convenience in reference the list is arranged alphabetically. The 7th edition of Gray's Manual is followed.

*For some of the results of these observations see the Bulletin from the Lab. of Nat. History, State Univ. of Iowa, Vol. VI, No. 1, and the Report of the Iowa Geological Survey, Vol. xx., both published in 1910 (in print at the time of the presentation of this paper).

LISTS OF PLANTS COLLECTED IN PRAIRIE OPENINGS.

- Achillea millefolium* L.
Agastache scrophulariæfolia
 (Willd) Ktze, (chiefly along the
 borders.)
Agropyron Smithii Ryd.
Allium canadense L.
Ambrosia artemisiæfolia L.
Ambrosia philostachya DC.
Amorpha canescens Pursh.
Andropogon furcatus Muhl.
Andropogon scoparius Michx.
Anemone cylindrica A. Gray.
Anemone patens var. *Wolfgangi-*
ana (Bess.) Koch. (In Winne-
 shiek county.)
Antennaria neodioica Greene.
Antennaria plantaginifolia (L.)
 Rich.
Agrostis hyemalis (Walt.) B. S. P.
Artemisia caudata Michx.
Artemisia dracunculoides Pursh.
Artemisia ludoviciana Nutt.
Asclepias purpurascens L.
Asclepias syriaca L.
Asclepias tuberosa L.
Asclepias verticillata L.
Aster azureus Lindl.
Aster lævis L.
Aster multiflorus var. *exiguus* Fer-
 nald.
Aster novæ-angliæ L.
Aster oblongifolius Nutt.
Aster sericeus Vent.
Bouteloua curtipendula (Michx.)
 Torr.
Brauneria pallida (Nutt.) Britt.
Cacalia atriplicifolia L.
Carex festucacea Schk.
Carex pennsylvanica Lam.
Carex tetanica var. *Meadii* (Dew-
 ey) Bailey.
Cassia chamæcrista L.
Castilleja coccinea (L.) Spreng.
Ceanothus americanus L.
Clematis virginiana L. (Borders
 chiefly.)
Comandra umbellata (L.) Nutt.
Convolvulus sepium L.
Coreopsis palmata Nutt.
Coreopsis tripteris L.
Crotalaria sagittalis L.
Dactylis glomerata L.
Dodecatheon meadia L.
Dysodia papposa (Vent.) Hitch.
Ellisia nyctelea L. (In somewhat
 sheltered places.)
Elymus canadensis L.
Equisetum arvense L. (Intro-
 duced.)
Erigeron canadense L.
Erigeron pulchellus Michx.
Erigeron ramosus (Walt.) B. S. P.
Eryngium yuccifolium Michx.
Eupatorium altissimum L.
Euphorbia corollata L.
Euphorbia maculata L.
Euphorbia Preslii Guss.
Fragaria virginiana Duches.
Gentiana puberula Michx.
Geranium caroliniana L.
Gnaphalium polycepalum Michx.
Hedeoma hispida Pursh.
Hedeoma pulegeoides (L.) Pers.
Helianthemum canadense (L.)
 Michx.
Helianthus occidentalis Rid.
Helianthus scaberrimus L.
Heliopsis scabra Dunal.
Heuchera hispida Pursh.
Hordeum jubatum L.
Hypoxis hirsuta (L.) Coville.
Isanthus brachiatus (L.) B. S. P.
Juncus tenuis Willd.
Krigia amplexicaulis Nutt.
Kuhnia eupatorioides var. *corymbu-*
losa T. & G.

Lappula Redowskii var. *occidentalis* (Wats.) Ryd.

Lepachys pinnata (Vent.) T. & G.

Lepidium apetalum Willd.

Lespedeza capitata Michx.

Liatris pycnostachya Michx.

Linum sulcatum Rid.

Lithospermum angustifolium

Michx. (Winneshiek county.)

Lithospermum canescens (Michx.)

Lehm.

Lobelia spicata Lam.

Monarda mollis L.

Monarda punctata L.

Nepeta cataria L. (Introduced.)

Oenothera biennis L.

Oenothera serrulata Nutt.

Oxalis stricta L.

Oxalis violacea L.

Oxybaphus nyctagineus (Michx.)

Sweet.

Panicum capillare L. (Introduced.)

Panicum Scribnerianum Nash.

Panicum virgatum L.

Parietaria pennsylvanica Muhl.

Pedicularis canadensis L.

Pentstemon lævigatus var. *digitalis* (Sweet) Gray.

Petalostemum candidum Michx.

Petalostemum purpureum (Vent.) Ryd.

Phlox pilosa L.

Physalis pubescens L.

Poa pratensis L.

Polygala senega L.

Polygala verticillata L.

Polygonum convolvulus L. (Introduced.)

Potentilla arguta Pursh.

Potentilla canadensis L.

Potentilla monspeliensis L.

Pycnanthemum pilosum Nutt.

Ranunculus fascicularis Muhl.

Rhus glabra L.

Rhus toxicodendron L.

Rosa humilis Marsh.

Rubus occidentalis L.

Rudbeckia hirta L.

Ruellia ciliosa Pursh.

Rumex crispus L. (Introduced.)

Salix humilis Marsh.

Scrophularia leporella Bickn.

Scutellaria parvula Michx.

Senecio plattensis Nutt.

Setaria viridis (L.) Beauv. (Introduced.)

Silene antirrhina L.

Silene stellata (L.) Ait.

Silphium laciniatum L.

Sisymbrium canescens var. *brachycarpon* (Rich.) Wats.

Sisyrinchium campestre Bickn.

Smilacina stellata (L.) Desf.

Solidago missouriensis Nutt.

Solidago nemoralis Ait.

Sorghastrum nutans (L.) Nash.

Sphenopholis obtusata var. *lobata* (Trin.) Scrib.

Taraxacum officinale Weber. (Introduced.)

Teucrium canadense L.

Thalictrum purpurascens L.

Tradescantia reflexa Raf.

Trifolium stoloniferum Muhl.

Verbascum thapsus L. (Introduced.)

Verbena angustifolia Michx.

Verbena bracteosa Michx.

Verbena hastata L.

Verbena stricta Vent.

Verbena urticifolia L.

Vicia americana Muhl.

Viola fimbriatula Sm.

Vitis vulpina L.

Xanthium commune Britt.

Zizia aurea (L.) Koch.

DELAYED GERMINATION.

BY L. H. PAMMEL AND CHARLOTTE M. KING.

In 1901 there was begun¹ a study of the germination of weed seeds under different conditions. It was observed that a large number of the weed seeds did not germinate freely in the fall.

In 1902 an experiment was performed with both mature and immature seeds. Plantings of these seeds were made in both fall and spring; the spring planting included both seeds which had been frozen and seeds which had not been frozen. It was found that seeds of different species showed great difference in germination. In general the results of 1902 and 1903 indicate that stratification in sand and freezing is favorable to germination; thus, in the Milkweed (*Asclepias syriaca*), there was no germination upon stratification but afterwards 12 per cent; Western Ragweed (*Ambrosia psilostachya*), none before and 18 per cent afterward; Lamb's quarter (*Chenopodium album*) none before and 88 per cent after stratification; Cocklebur (*Xanthium canadense*) none before and 25 per cent afterward.

Subsequently Mr. H. S. Fawcett² made a study of 52 different samples of mature weed seeds representing 52 different species. The samples were collected in September, October and November of 1904. The seeds were threshed out and placed in paper envelopes. Fifty seeds of each sample were placed in sand in boxes in a greenhouse and kept under conditions as nearly uniform as possible. The tests were repeated each month from November until May and all boxes of the previous months left. They were kept moist during the winter. In addition a large number of weed samples was placed out of doors to expose them to the freezing and thawing, the seeds being placed in sacks in a wooden box covered with a thin layer of sand; the box was sunk in the ground not more than a foot below the surface and left there all winter. The general effect of the thawing and freezing was to increase the percentage

¹Pammel, L. H. Proc. Soc. Prom. Agrl. Sci. 24:89.

²The Vitality of Weed Seeds under Different Conditions of Treatment and a Study of the Dormant Periods. Proc. Ia. Acad. Sci. 15:25.

of germination and lessen the dormant period, especially true of seeds with hard coats; where the coats were thin the dormant period was still less than with hard coated seeds. For instance the dormant period of common Pig Weed (*Amarantus retroflexus*) was nine and one-third days when kept in packages in a dry room and only six and one-third days after having wintered out of doors. In the case of Wild Rye, the dormant period was lessened from nine to five days. In the common Foxtail (*Setaria glauca*) the average dormant period was lessened from eleven to seven and one-fourth days and the percentage of germination from 34.5 per cent to 38 per cent, while the percentage of germination in the Wild Rye was increased from 22 per cent to 48 per cent and the Pig Weed increased from 40 per cent to 50 per cent. In general, the longest dormant period was found in those seeds which have the hardest and thickest seed coats. The longest dormant period for the Great Ragweed was 152 days; the Barn-yard Grass, 178 days. In this connection it is also interesting to observe that the highest percentage of germination for any planting was the common Mustard (*Brassica arvensis*) which was 100 and for the six plantings, 90.3 per cent.

It has been known for a long time that many seeds refuse to germinate until they have passed a period of rest; Dr. MacDougal³ calls attention to an interesting condition observed in Arizona in regard to some of the annual plants in which delayed germination occurs. Nobbe and Hanlein,⁴ who made a study of the weed seeds of thirty-one different species and continued their experiments for 1,173 days, found a number of these weeds showed germination after a lapse of 1,173 days and among them were *Campanula persicifolia*; *Chelidonium majus*; *Mysosurus minimus*; *Plantago media*; *Potentilla argentea* and *Thlaspi arvense*.

Winkler⁵ observes that the seeds of *Euphorbia Cyparissias* though planted in the spring did not germinate in some cases until forty years later. He states also, that the seeds of *Malva moschata* will not germinate in the season of their production.

Wiesner⁶ states in some cases nine years are required for the germination of *Euphorbia exigua*. He notes, also, the well-known fact that in the case of Red Clover *Trifolium pratense*, some seeds will germinate the

³The Course of the Vegetation in Southern Arizona. Plant World Nov., 1908. Separate 13.

⁴Ueber die Resistenz von Samen gegen die ausseren Factoren der Keimung. Landw. Versuchs-Stat. 20:63-96. 1877; the original of this paper was not available, the facts are taken from Crocker. Hanlein, Ueber die Keimkraft von Unkrautsamen. Landw. Versuchs-Stat. 25:465-470. 1880.

⁵Bemerkungen uber die Keimpflanzen und die Keimfahigkeit des Samen von *Tithymalus Cyparissias*. Ber Deutsch. Bot. Gesells. 1:452-455. 1883.

first year while others later. The same is true of the Black Locust, *Robinia Pseudo-Acacia* and *Cytisus Laburnum*. In these seeds the differences are due to the unequal ability of taking up water required for germination. Delayed germination was also observed in *Reseda lutea* and *Dianthus armeria*.⁶ The seeds of *Sonchus oleraceus* are said not to germinate the following season but to do so at a later period. Wiesner found in the case of *Viscum album*, that the seeds would germinate only sparingly in the fall but readily in the following spring; that these seeds have dormant periods of at least six months and that light is favorable for their germination.

Gifford is authority for the statement in the case of the White Pine that a few seeds will germinate the first year, a large number the second and a few the third. It is well known that cones of the Jack Pine often hang on the tree for twelve or thirteen years—according to Sudworth⁷ seven to nine years; also that when a fire passes through, the cones burst open and the seed is ready to germinate. In many cases the seeds of forest trees will germinate better after being subjected to freezing, or in other cases endure freezing but germinate quite as well if not frozen. Many of the seeds of our common Red Cedar will not germinate the first season.

How long some seeds will retain their vitality has never been definitely determined for many species, although we have accurate data for many seeds, particularly the exhaustive work by DeCandolle.⁸ It was found by this author that out of 368 seeds kept dry in air for fifteen years, only a small number—17, were capable of germinating. Of these, five species of *Malvaceae*, 9 species of *Leguminosae*, and one *Labiatae*. The experiments of Beal¹⁰ are of interest in this connection.

In 1879, Dr. Beal selected 50 freshly grown seeds of each of 23 different kinds of plants. The seeds were well mixed with moderately moist sand; the mixture was then placed in a pint bottle, which was left uncorked, with the mouth slanting downward so that no water could collect about the seeds. The bottles were then buried three feet below the surface in a sandy knoll and at the end of 5, 10, 15, 20, and

⁶Biol. der Pflanzen, 45.

⁷Ueber die Ruheperiode und von einige Keimungsbedingungen der Samen von *Viscum album*. Ber. Deutsch Bot. Gells. 15:505-515. 1897. See Kienitz Bot. Centralb. 1:53.

⁸Bull. Div. of Forestry, U. S. Dept. of Agr., 29:35.

⁹Sur la Duree relative de la faculte de germer Ann. Sci. Nat. III, 6:373. 1846. Physiologie vegetale 2:618.

¹⁰Proc. Soc. Prom. Agrl. Sci. 26:89-1905.

25 years, sets of seed were tested for vitality. The following results were obtained:

Name of Seeds—Tested as Known in 1879	5 yr.	10 yr.	15 yr.	20 yr.	25 yr.
<i>Amaranthus retroflexus</i>	+	+	+	+	+
<i>Ambrosia artemisiæfolia</i>	0	0	0	0	0
<i>Braasica nigra</i>	0	+	+	+	+
<i>Bromus secalinus</i>	0	0	0	0	0
<i>Capsella Bursa-pastoris</i>	+	0	+	+	+
<i>Erechthites hieracifolia</i>	0	0	0	0	0
<i>Euphorbia maculata</i>	0	0	0	0	0
<i>Lepidium virginicum</i>	+	+	+	+	+
<i>Lychnis Githago</i>	0	0	0	0	0
<i>Maruta Cotula</i>	+	+	+	0	+
<i>Malva rotundifolia</i>	+	0	0	+	0
<i>Oenothera biennis</i>	+	+	+	+	+
<i>Plantago major</i>	0	0	+	0	0
<i>Polygonum Hydropiper</i>	0	+	+	+	+
<i>Portulaca oleracea</i>	0	+	+	+	+
<i>Quercus rubra</i>	0	0	0	0	0
<i>Rumex crispus</i>	+	?	+	+	+
<i>Setaria glauca</i>	+	+	+	0	+
<i>Stellaria media</i>	+	+	+	+	+
<i>Thuja occidentalis</i>	0	0	0	0	0
<i>Trifolium repens</i>	0	0	0	0	0
<i>Verbascum Thapsus</i>	+	?	+	+	0

It was found that 8 out of 22 failed to germinate. All the acorns which were not placed in bottles were dead in two years.

Prof. L. R. Waldron* records some valuable experiments with buried seed of seven different common weeds.

In fall of 1889, these were planted in a seed-bed out of doors at depths of 1, 2, 3, 4, 5, 7 and 10 inches.

During the same fall Shepherd's Purse produced a few plants at depth of 1 and 2 inches; French weed 25 plants at 1 inch; wild mustard many plants at 1, 2, and 3 inches; wild oats several plants at 1, 2 and 3 inches.

During 1900 the seeds continued to germinate and it was true of them that the small weed seed did not come up through 2 inches of soil; no seeds buried below 3 inches germinated except Kinghead or Great Ragweed and wild oats, which came up through 5 inches of soil.

These data were furnished for the following weeds: Shepherd's Purse, Frenchweed, Green Foxtail, Kinghead, Wild Mustard, Wild Buckwheat, Wild Oats.

*Bull. 62, N. Dak. Exp. Sta., p. 439-445.

Becquerel¹¹ extended the observations of DeCandolle by removing the integuments sterilizing, and soaking the seeds and keeping them in moist cotton.

Of the 550 species studied by him, belonging to thirty orders of plants, the age of seeds varied from 25 to 135 years. The seeds from the following years germinated: *Acacia bicapsularis* from 1819; *Cytisus biflorus* of 1822; *Trifolium arvense* of 1838; *Ervum lens* of 1841; *Dolichos funarius* of 1868; *Nelumbium codophyllum* of 1850; *N. asperifolium* of 1858; *N. speciosum* of 1888; and *Lavatera pseudo-alba* of 1862.

None of the old seeds of the following orders germinated, *Juncaceae*, *Liliaceae*, *Chenopodiaceae*, *Papaveraceae*, *Caryophyllaceae*, or *Cucurbitaceae*.

Recently A. J. Ewart¹² has published an exhaustive work on the longevity of seeds. A large number were tested and the records of many are given. It would seem from the work of Ewart that many seeds have a prolonged vitality, some upwards of 50 and 80 years. A few of the results of his studies are given here:

¹¹Ann. d. Sci. Nat. Bot. IX, 5:193-320. 1907. Compt. Rend. de l'Acad. des Sci. 142:1549.

¹²Proc. Roy. Soc. of Victoria. 21:1 pt. 1, 1. 1898.

Name of Seed	Years Old	No. of Seeds	Percent- age of Germina- tion
<i>Malvaceae</i> —			
Abutilon avicennæ	57	45	6
Var. Behriana			
Hibiscus trionum	57		12
Gossypium herbaceum	10		80
<i>Leguminosae</i> —			
Acacia diffusa	57	32	9
Acacia penninervis	57	15	13.3
Cytisus albus	51	54	78
Melilotus alba	44	250	52
Melilotus alba	77	1000	18.2
<i>Nymphaeaceae</i> —			
Nelumbium luteum	55	6	63
<i>Rhamnaceae</i> —			
Ceanothus Americanus	15	20	0
<i>Cruciferae</i> —			
Brassica alba	77	115	0
<i>Compositae</i> —			
Cichorium intybus	10	100	50
Helianthus annuus	15	20	0
<i>Gramineae</i> —			
Triticum vulgare	10	100	75
Zea Mays	7	100	36
Bromus mollis	10	250	0

THE PROLONGED VITALITY OF SEEDS.

The explanation of this must be sought not only in the structure of the seed coat but in the amount of respiration that is carried on at least at times and depends on external conditions and lastly upon certain heritable qualities. One is perhaps not very far wrong in concluding with Kolkwitz¹³ that respiration is not essential to continue the vitality of seeds since many seeds will not lose their vitality by prolonged heating. Thus Pouchet¹⁴ states that the vitality of the seeds of *Medicago sativa* was not destroyed when heated with steam heat for four hours; and Haberlandt¹⁵ found that a large number of seeds of sixty-four different species did not lose their vitality after having been heated to 100 degrees C. for forty-eight hours. Among these we may mention some of the seeds of *Gramineae*, *Leguminosae*, *Cucurbitaceae*, etc. Such seeds usu-

¹³Berichte d. Bot. Gesell. 19:285.

¹⁴Compt rend. 63:939.

¹⁵Allgem. Land. -u. forstw. Zeit. 1:389.

Untersuchungen auf dem Gebiete des Pflanzenbaues. 2:79.

ally germinate more rapidly than the untreated. The whole subject has been discussed by Detmer.¹⁶

Schroder¹⁷ has shown that barley containing only two per cent of water germinated well after an interval of twelve weeks. Jost¹⁸ calls attention to the fact that seeds of the grass type which can withstand thorough drying as a rule retain their powers of germination only for a limited number of years. "What the laws of germinating power depend on in the long run is not known, but when we reflect that gradual altering to reduce their solubility, we may conclude that specific protoplasmic bodies undergo as time goes on, alterations calculated to render them functionless. At all events it is quite out of the question to suppose that death of the resting seed is brought about by using up reserve substances in respiration.

The writer some years ago made a test of corn kept under different conditions. One sample which germinated 100 per cent early in the spring, in the course of two months, subject to the various changes of the weather, dropped to 66 per cent. In another sample kept in the laboratory, the germination during the early spring was 98 per cent; kernels taken from the same ear two months later dropped to 80 per cent. The loss in vitality here was undoubtedly due to the absorption of moisture and respiratory changes that occurred in the seed, and Ewart¹⁹ suggests that longevity depends not on food materials nor seed coats but upon how long the inert proteid molecules into which the living protoplasm disintegrates when drying, retain the molecular grouping which permits of their re-combination to form the active protoplasmic molecule when the seed is moistened and supplied with oxygen. The same author further demonstrated²⁰ that "seeds capable of withstanding thorough drying assume a perfectly dormant condition in which they do not respire and are not living although they have a power of restoring life potential in them for a longer or shorter period of years." And Becquerel concludes that only those seeds can preserve their vitality which have thick coats and are impermeable to water and oxygen and do not have a large amount of oxydizable reserve matter. This conclu-

¹⁶Vergleichende physiologie des Keimungsprocesses der Samen. 402.

See also paper by Edwards and Colin, Ann. d. Sc. Nat. Bot. 1:264. 1834. Sachs Handbuch d. Experimental physiologie d. Pflanzen. 66.

¹⁷Unters bot. Inst. Tübingen. 2:1.

¹⁸Lectures on Plant Physiology, Eng. Trans. by Gibson. 342.

¹⁹Proc. Roy. Soc. of Victoria. 21:184, 1 pt.

²⁰Trans Liverpool Biol. Soc. 8:234. 1894.

sion, however, is incorrect, as Ewart states, because the long-lived seeds, and many of them have starchy material, are found in the *Leguminosae*.

Some years ago one of us²¹ made a study of the seeds of leguminous genera found in Gray's Manual. It was found that nearly all of the seeds studied had a cuticle, especially pronounced in the *Mimoseae*, *Caesalpinieae* and most of the *Papilionaceae*. Many of the seeds are known to have an especially long vitality.

It has long been known that some of the seeds of the *Leyuminosae*, especially clover, will not germinate the same season that they are planted. The best seeds of the red clover are the purple, these are also the hardest. Hiltner²² was the first to show that when hard seeds of clover are treated with sulphuric acid they germinate after treatment. Jarzymowski,²³ Ewart and others have shown that such treatment hastens germination. Bergetheil and Day²⁴ and Miss White²⁵ have shown that the cuticle is impermeable to water.

It has long been known that certain paired seeds like the cocklebur will not germinate the same season. The cocklebur seeds were first carefully studied by Arthur²⁶ who found that generally the germination of one seed is delayed although both may germinate the same season. Nobbe and Hanlein's observation on some weed seeds show the same facts.

AN EXPERIMENT WITH SOME IOWA WEED SEEDS.

In 1906 an experiment was started with 130 different kinds of weed seeds. The seeds were mature so far as we could tell. They were placed in paper packages and left in the laboratory. Plantings were made as follows: November, December, January, March and April. A second set of samples of the same weed seeds of 130 species was placed in linen sacks, covered with earth and buried six inches in the soil. They were thus subject to the varying conditions of an Iowa winter. These seeds were carefully removed in April and planted with the other samples for comparison. The tables are too long to produce in this con-

²¹Pammel, L. H. Trans. Acad. Sci., St. Louis, 9:89.

²²Arch. aus d. biol. Abt. f. Land-u. Forst. Wiss. 3:30, 1902.

²³Inaug. Diss. Halle. 1905,

²⁴Ann. of Bot. 21: Jan., 1907.

²⁵Proc. Royal Soc. Victoria. 21:203.

²⁶Proc. Soc. Prom. Agrl. Sci. 16:70.

²⁷Ueber die Resistenz von Samen gegen die aussern Factoren der Keimung Landw. Versuchs. Stat. 20:63. Ueber die Keimkraft von Unkrautsamen. Landw. Versuchs Stat. 25:465.

nection. The germination of a few typical illustrations may be brought together in the following table.

PERCENTAGE OF SEEDS GERMINATED BY MONTHS.

Name of Weed	Nov.	Dec.	Jan.	Feb.	Mch.	April	Fr'z'n April
1. <i>Abutilon Theophrasti</i>	9.	37.3	11.3	28.6	27.7	37.3	36.
2. <i>Amaranthus graecizans</i>	9.3	2.6	.66	0	10.	7.3	32.
3. <i>Ambrosia artemisiæfolia</i>	9.2	8.	8.	7.	7.	26.	21.5
4. <i>Arctium Lappa</i>	10.	6.	1.5	1.33	2.	2.6	.42
5. <i>Apocynum cannabinum</i>	54.	12.25	4.	-----	2.	46.	54.
6. <i>Brassica arvensis</i>	25.5	39.	34.	33.	19.	52.	44.
7. <i>*Cicuta maculata</i>							
8. <i>Cassia Chamæcrista</i>	16.3	13.6	15.3	3.	2.	8.6	33.
9. <i>Chenopodium album</i>	22.6	20.6	2.6	19.3	15.3	3.	44.6
10. <i>Cirsium lanceolatum</i>	14.	13.3	9.	1.	20.6	16.	34.6
11. <i>Echinochloa crusgalli</i>	4.6	17.	4.	3.	8.5	13.6	57.
12. <i>Lactuca Canadensis</i>	0	2.6	.50	7.	2.	2.	39.3
13. <i>Melilotus alba</i>	2.5	4.	2.6	6.6	2.5	6.	11.3
14. <i>Plantago major</i>	4.	9.5	.50	1.3	1.5	5.5	32.
15. <i>Polygonum pennsylvanicum</i> ..	3.	5.5	8.5	0	1.	0	45.
16. <i>Panicum capillare</i>	4.5	8.6	5.	2.6	1.	8.5	28.
17. <i>Rumex crispus</i>	15.3	18.5	1.5	12.	15.4	12.	36.
18. <i>Setaria glauca</i>	5.5	10.	7.5	.66	50.5	32.	35.7
19. <i>Verbena urticæfolia</i>	5.5	5.	1.	.66	4.5	5.3	31.5

The foregoing table further illustrates the differences caused by freezing in the germination of weed seeds; for in the most cases, the germination was greater after the seeds had been subjected to thawing and freezing than when kept in packages in a dry room. Of the November planting, November, 1908, of a total number of 65 species, four species failed to germinate; of 60 species in December, 48; of 63 species in January, 44; of 62 species in March, 27; of 59 species in April, 46; of the seeds exposed to the weather, 64 species, 24 failed to germinate.

The seeds of many of the weeds germinate in a very irregular manner. A few may be given to illustrate this:

*No results.

PERCENTAGES BY MONTHS AND YEARS.

Name of Weed	Nov.			Dec.			Jan.			March			April			April 1st Subject- ed to Freez- ing
	1905	1906	1907	1908	1905	1906	1907	1908	1905	1906	1907	1908	1905	1906	1907	1908
<i>Amaranthus retroflexus</i> -----	32	6	12	0	38	10	2	2	4	12	0	0	6	26	4	--
<i>Bidens frondosa</i> -----	8	4	4	0	2	0	6	0	0	2	0	0	0	6	--	0
<i>Datura stramonium</i> -----	0	22	100	--	0	50	70	--	0	32	20	--	0	22	40	--
<i>Helenium autumnale</i> -----	--	2	0	--	6	0	--	--	6	0	--	--	0	--	4	--
<i>Lepidium apetalum</i> -----	32	14	22	--	32	64	24	--	40	56	2	--	28	94	58	--
<i>Pastinaca sativa</i> -----	--	2	30	16	--	10	68	20	--	6	0	8	--	8	52	20
<i>Setaria viridis</i> -----	42	14	10	0	66	34	--	0	18	28	2	2	6	50	0	8
<i>Sonchus oleraceus</i> -----	52	2	2	--	42	26	6	--	--	2	0	--	--	0	2	--

The results of these tests seem to indicate the uncertainty with reference to the germination of these various species of plants. It has been shown by Dr. Beal²⁸ that certain seeds when buried soon lose their vitality. This was true of *Bromus secalinus* and Duvel²⁹ has shown this to be true also for some seeds studied by him. The average germination in buried seeds was as follows: Original tests, 63.2 per cent; control in chamber, 57.5 per cent; control in greenhouse, 53.2 per cent; buried 6-8 inches, 20.5 per cent; buried 18-22 inches 26.5 per cent; buried 36-42 inches, 31 per cent. This writer also indicates that there was a considerable loss in the vitality of seeds with hard coats like *Lespedeza* and *Medicago*. For instance, in the case of red clover, seed harvested in the same year was planted in 1902, germinated 2.4, and 4 per cent for the three different depths of 6-8, 18-22 and 36-42 inches. The hard seed in the clover remained over in the soil. He concludes that the seeds of cultivated plants with but few exceptions lose their vitality when buried in the soil. That seeds of the plants commonly designated as weeds retain their vitality remarkably well when buried in the soil.

Wiesner³⁰ states that the seeds of *Pontederia crassipes*, *Mayacca fluviatilis*, *Heteranthera* will germinate in water if previously dried out in the air, according to F. Muller³¹ and according to Bohm³² *Phaseolus multiflorus* will not germinate in the absence of lime salts.

²⁸Bull. Mich. Agrl. Col. 5:1884.

²⁹The Vitality of Buried Seeds, Bull. B. P. I. U. S. Dept. of Agrl. 83.

³⁰Biol. der Pflanz. 45.

³¹Cosmos. 7:183.

³²Sitzungab. d. Kais. Akad. d. Wis. Wien. 71.

See also Stohman Ann. d. Chem. u. Pharm. 1862. 121:319.

It may be added that Schofield³⁸ found that the seeds of *Zizania aquatica* soon lose their vitality if exposed to the air and that they germinate only when kept in moist earth or mud. Mr. J. J. Thornber³⁹ finds that with seeds flooded to a depth of 12 inches for a period of 30 days, there were obtained germinations as follows: Bermuda grass 42 per cent, Johnson grass 45 per cent, *Sesbania macrocarpa* 75 per cent. When extended to 50 days, Bermuda grass germinated 14 per cent, Johnson grass 23 per cent. After submergence of 21 days, radish, rutabaga, sugar beet and tomato seed germinated 100 per cent, cabbage and celery seed 75 per cent, and water melon 33 per cent.

There may be mentioned in connection with studies of germination under induced conditions, the experiments of Italo Giglioli⁴⁰ who has shown that latent vitality may occur in seeds when surrounded by gases and liquids. The seeds of alfalfa when in nitrogen dioxide for 776 days germinated 43 per cent, sulphuretted hydrogen 976 days germinated 58 per cent; arseniuretted hydrogen 802 days germinated 87 per cent. The seeds were air dry and placed in bulbs. In regard to liquids the results are surprising, methyl alcohol 841 days, per cent of germination 19 per cent; carbon disulphide 405 days per cent of germination 63.2. Moist seeds kept in oxygen and in nitrogen protoxide do not germinate. Alcoholic solution of iodine 382 days, per cent germination 1.5, alcoholic solution of potassium bromide 757 days 68.4. Giglioli re-examined the seeds of alfalfa which had been kept in the gases and liquids during this time; Hydrogen 16 years, none germinated; wheat and cynara gave the same result. With chlorine and hydrochloric acid gas, seeds of alfalfa 16 years, 3 months and 5 days old, 6.72 per cent germinated. Alcoholic solution of sulphuretted hydrogen, alfalfa 15 years, 9 months, 15 days, 7.03 per cent germinated. These experiments seem to show that seeds may retain their vitality when all respiratory exchange is completely prevented for a long series of years.

To test the vitality of clover seed gathered in the year 1905, the following experiment was conducted;⁴¹ the seeds were treated with hot water, dilute sulfuric acid, concentrated sulfuric acid and, in one case, by scratching.

³⁸The Viability of Seeds. Plant World 11:158.

³⁹Latent Vitality of Seeds. Nature 52:544. Action of Gases and liquids on the Vitality of Seeds. 35:328.

Gazette Chimica italiana. 9:19. 1879.

Gior delle staz sper, ital. 8:199. 1874.

⁴¹This experiment was conducted by J. R. Campbell under our direction.

PERCENTAGE OF GERMINATION AFTER TREATMENT.

	Germina- tion in 24 Hours	Germina- tion in 48 Hours	Germina- tion in 72 Hours	Final
<i>Check—</i>				
Purple, '06.....	1	3	14	15
Yellow, '06.....	0	3	11	12
Purple, '09.....	14	23	30	30
Yellow, '09.....	3	46	48	48
<i>Hot Water—</i>				
Purple, '06.....	0	0	0	1
Yellow, '06.....	0	0	0	0
Purple, '09.....	0	0	1	1
Yellow, '09.....	0	1	2	2
<i>Sulphuric acid—</i>				
Purple, '06.....	0	1	4	6
Yellow, '06.....	0	2	7	10
Purple, '09.....	4	37	42	42
Yellow, '09.....	4	17	18	19
<i>Sulphuric acid, 2 min.—</i>				
Purple, '09.....	2	5	10	12
<i>Scratched—</i>				
Purple, '06.....	0	5	11	14
Yellow, '06.....	1	3	9	9
<i>No. 82—</i>				
Purple, '09.....	25	33	42	42
Yellow, '09.....	5	35	36	36
<i>No. 70—</i>				
Purple, '09.....	21	30	35	35
Yellow, '09.....	33	35	39	40
<i>No. 71—</i>				
Yellow, '09.....	29	30	41	41

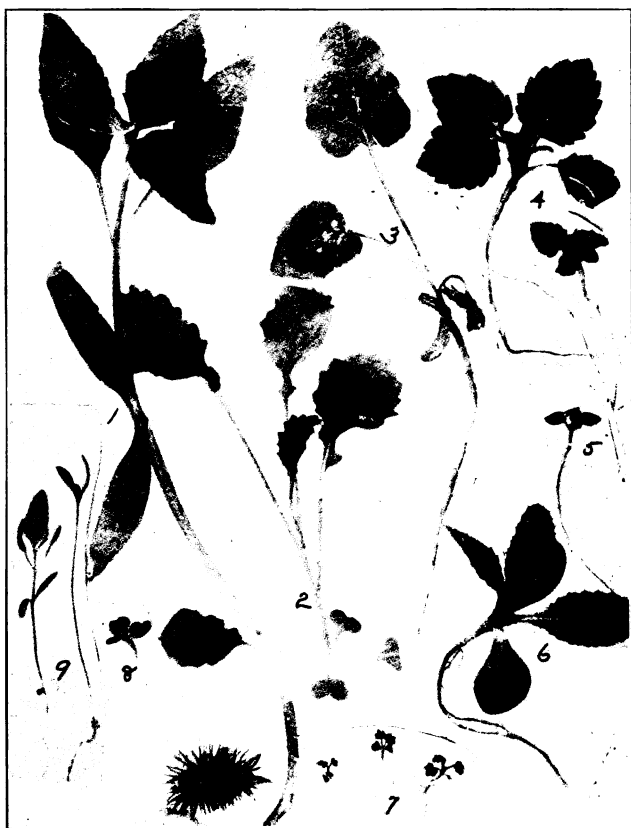
Undoubtedly the hard clover seeds as well as the hard seeds of other plants are for the purpose of tiding the seed over unfavorable conditions. It has been well said by Mr. Ewart, "Macrobiotic seeds are all seeds which show no especial adaptation for dispersal. None are wind or water borne and although some are more or less accidentally distributed by animals, adhesive seeds or fruits are conspicuously absent among them. They are, in fact, distributed in time instead of in space. Falling to the ground beneath or close to the parent plant, a few are immediately germinable but others only after long periods of years or after special actions have been brought to bear upon them."

The case is, however, very different with many seeds that are found in low damp situations like the willow and the cottonwood and the soft

maple. The seeds fall on the damp earth or mud and here the conditions are favorable for immediate germination.

The seeds of the ash and horn-bean begin to germinate the year after they ripen; it is also known that the seeds of many trees and some shrubs which mature early in the season do not retain their vitality for germination a great length of time. The following experiment was conducted with the common soft maple (*Acer saccharinum*).

On June 3d the samaras of the species were beginning to fall from the trees. They were collected and kept under different conditions as follows: A large number of seeds were stored in the cooling room of the college creamery at 45 degrees F.; another sample was left in the laboratory exposed to dry atmosphere; still another sample was left in a pasteboard box between folds of damp cloth; another was placed in damp sand immediately after being picked from the ground.



Some weed seedlings.

1. *Xanthium canadense*.
2. *Brassica nigra*.
3. *Arctium Lappa*.
4. *Scrophularia nodosa*.
5. *Eupatorium*.
6. *Cirsium lanceolatum*.
7. *Nepeta cataria*.
8. *Solidago rigida*.
9. *Chenopodium album*.

Kind of Seed and Treatment	Col- lected	Plant- ed	Days Dormant	Per cent Germi- nation
<i>Soft Maple—</i>				
1. Placed in damp cloth; be- came slightly mouldy..	6- 3-09	6- 7-09	7th day, 2; 8th, 23; 9th, 7; 10th, 2; 11th, 6; 12th, 2; 13th, 1; 14th, 1; 15th, 2; 16th, 1; 22d, 2.....	75
2. Placed in paste board box in laboratory and kept dry	6- 3-09	6- 7-09	8th, 5; 9th, 12; 11th, 4; 12th, 3; 13th, 2; 14th, 1; 15th, 1; 17th, 1.....	58
3. Picked from the ground.	6- 3-09	*	9th, 1; 10th, 1; 11th, 4; 12th, 8; 13th, 6; 14th, 1; 15th, 1; 16th, 3; 17th, 3; 18th, 4; 21st, 2; 22d, 1; 26th, 5	40
4. Kept in laboratory and al- lowed to dry out. Seeds had become much more shriveled than they were in sample No. 2, but still green	6- 3-09	6-18-09	11th, 10; 13th, 3; 17th, 4; 19th, 1; 20th, 1; 28th, 1; 29th, 1	42
5. Seeds collected from the ground. In fairly good condition. The cotyle- dons were green	6-18-09	6-18-09	7th, 1; 8th, 2; 9th, 2; 10th, 2; 11th, 17; 13th, 3; 14th, 2; 15th, 1; 16th, 1; 20th, 1	32
6. Kept in laboratory. Same condition as No. 2. Seeds had become very much shriveled and dried out	6- 3-09	6-26-09	13th, 1; 15th, 1; 17th, 1..	6
7. Seeds kept in cooling room at the creamery at the following tempera- ture: 45°F. Seeds slight- ly shriveled but the coty- ledons green. Plants are not mouldy		7- 7-09	6th, 1; 7th, 0; 8th, 1; 9th, 6; 10th, 6.....	28

It appears from these tests that the soft maple having a very thin seed coat does not retain its vitality for a great length of time because the loss of water is very rapid. Germination may be delayed by keeping the seeds at a nearly uniform temperature in a refrigerator or cooling room. Of one hundred seeds collected on July 5th from under the trees where they had fallen, none were found which were capable of germination. Many of them, or nearly all of the seeds were decomposed.

*Immediately.

THE PROBLEM OF WEEDS IN THE WEST.

BY L. H. PAMMEL.

Weediness is an indication of poor farming. It has been said by some one that the farmers of the east do not fear the Canadian Thistle or other aggressive weeds because the better methods of tillage make the fields clean.

The average yield of corn in Iowa according to the latest statistics is 32.9 bushels per acre. This can by proper methods of cultivation be more than doubled. According to the Year Book of the United States Department of Agriculture for 1903, the yield of corn per acre in Iowa from 1894-1903 was as follows: 1894, 15.0; 1895, 35.1; 1896, 39.0; 1897, 29; 1898, 35; 1899, 31; 1900, 38; 1901, 25; 1902, 32.0; 1903, 28. During this period most of the years the state of Maine had a greater yield per acre than Iowa. Iowa is in the corn belt and has a greater acreage than any other state in the Union. A part of the low yield is due to unfavorable seasons as in 1894. We have not, however, had a year since then which was in any way unfavorable for a good or fair crop of corn. The unfavorable crop returns then must be due to other causes, chief among these are the weedy fields. In the year 1908 the writer had estimates made of the yield of some typical corn fields in Iowa. It was found that good clean fields yielded 50 to 60 bushels per acre while the weedy fields only between 25 and 30. An increase of 20,000,000 bushels in Iowa should be possible by better methods of cultivation. This would mean that the farmers could easily increase their wealth by \$8,000,000, allowing a little extra expense for labor.

The present day farming in the corn belt is an economic waste. Most of the weeds are easily destroyed, like the Pigeon Grass (*Setaria glauca*), Foxtail (*Setaria viridis*), Smartweed (*Polygonum pennsylvanicum* and other species), the Cocklebur (*Xanthium canadense*), Ragweed (*Ambrosia trifida*) and *A. artemisiifolia*, etc. Nearly all of our troublesome weeds are those common to the east and in Europe. Such perennial weeds as Quack Grass (*Agropyron repens*) and the Canadian Thistle, Horse Nettle (*Solanum carolinense*) are local. To the north as in Minnesota and Wisconsin such perennial weeds as the Quack Grass and Ca-



Perennial Ragweed (*Ambrosia psilostachya*), Cleome, Sweet Clover, Lepachys and other weeds of the streets of Fort Collins, Colorado.

nadian Thistle are more common. Different crops and different regions produce weeds which may become locally prominent. In southern Iowa the Horse Nettle and Cocklebur are more abundant than in Northern Iowa. In western Iowa the Marsh Elder (*Iva xanthiifolia*) is an immigrant from the west, and it has extended northward into Canada. In the Red River Valley of the North, the *Iva xanthiifolia* known locally as the half-breed weed is abundant. One sees, however, little of such common Iowa weeds as the Mayweed (*Anthemis Cotula*) and Butter-print or Indian Mallow (*Abutilon Theophrasti*). Nor is the large Rag-weed (*Ambrosia trifida*) as common as in Iowa. The Woolly Thistle (*Cirsium canescens*) is abundant.

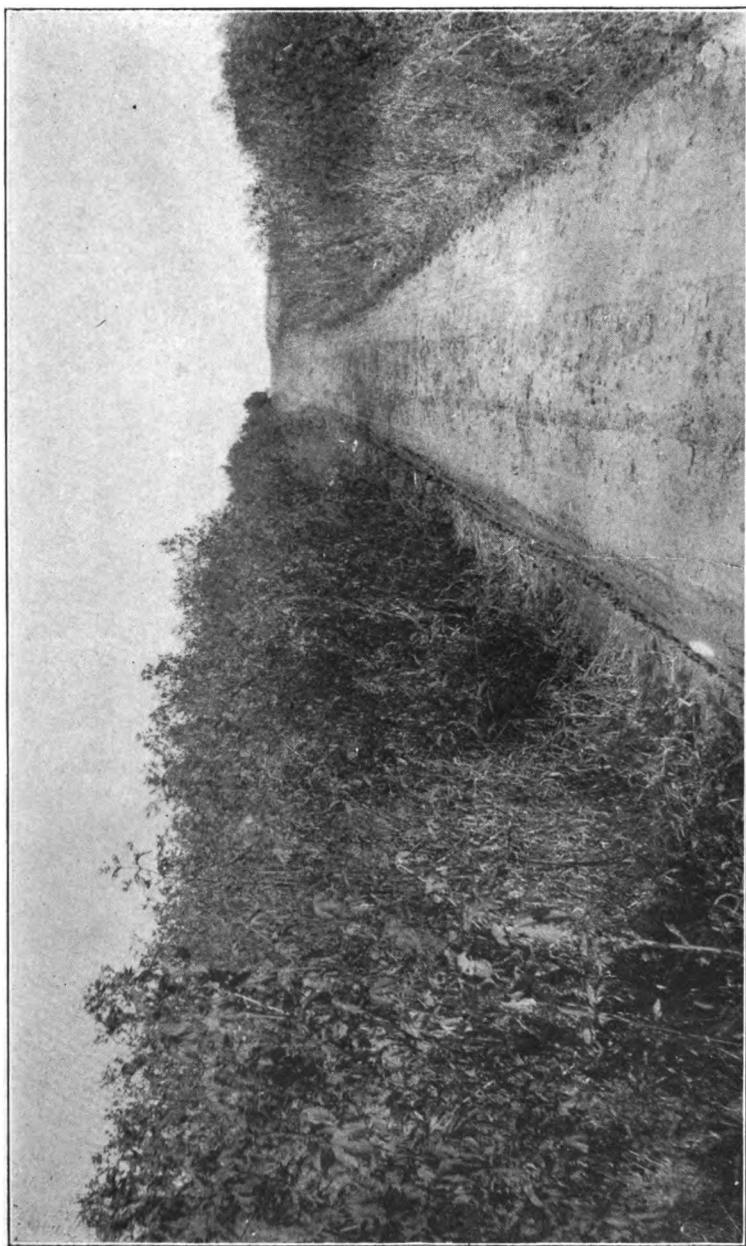
As we cross the boundary line or approach it, we see that one of the native shrubs of that country (*Eleagnus argentea*) spreads rapidly where the surface of the soil has been removed, very much as the cottonwood does in Iowa or in other parts of northern United States.

In the country from Winnipeg to Vancouver and the Rocky Mountain states, the common Squirreltail Grass (*Hordeum jubatum*) is one of the most striking weeds in fields and waste places. It is, of course, a striking weed also in Iowa, but it was rare here prior to 1876. Cultivation and neglect of tillage has caused these weeds to become extensively scattered. Weeds adapt themselves to conditions most suited for their environment and it strikes one as peculiar that the most common ruderal plants of Iowa, like the Green Foxtail and Pigeon Grass, as well as the Crab Grasses are as yet of little importance in the Canadian Northwest although troublesome in the Mississippi valley. They occur across the continent and on the Pacific coast but do not cover the ground as they do here. To the south in Montana, Idaho, and especially Colorado and Utah, they have become common. The Wild Oats (*Avena fatua*) is common in the northwest as it is in parts of Minnesota and the irrigated districts of the Rocky Mountains, largely because the weed is spread with the culture of oats. The Holy Grass (*Hierochloe borealis*) a well known native grass of the north is comparatively rare in Iowa, except northward and it is not known to be weedy in that section of the state. However, in the Canadian northwest it is a persistent and troublesome perennial weed. Other somewhat weedy grasses are Awnless Brome Grass (*Bromus inermis*), Common Cheat (*Bromus secalinus*) and the Darnel (*Lolium temulentum*). Today it is difficult to find common Cheat in many parts of Iowa largely because we no longer grow wheat but the Soft Chess (*Bromus mollis*) is coming in rapidly. In Utah the *Bromus tectorum* and *Hordeum murinum* have become most troublesome

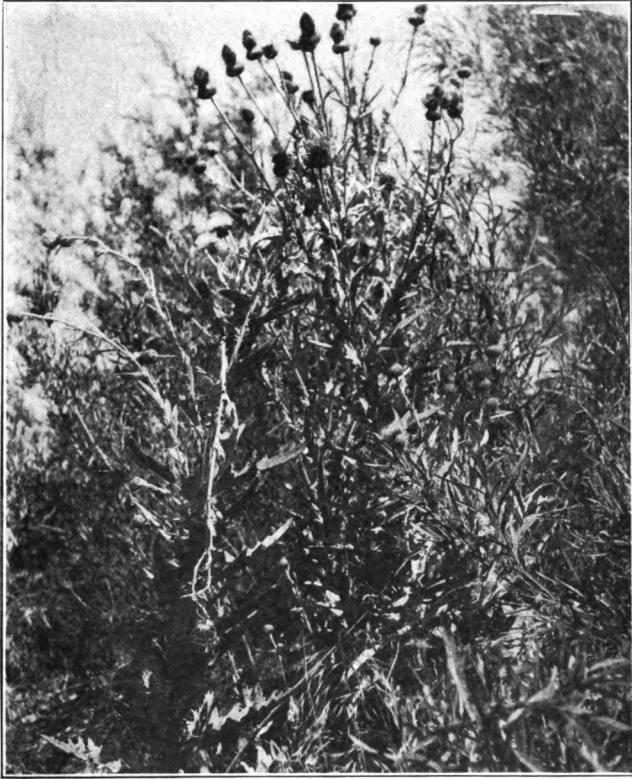
weeds and rapidly spreading to Colorado. With us the *H. pusillum* is making its way northward into Central Iowa.

The next great family of interest is the Composite Family; the plants are plastic and aggressive, the old world species more so than those of the new world. In Iowa most of our composite weeds are from the old world but in the Canadian Northwest and in the West there are many indigenous native species. The Gum-wood, (*Grindelia squarrosa*) although I have known it for some years in Central Iowa, is not spreading. This weed is common from Winnipeg westward through the Rocky Mountains south to Minnesota and Western Iowa. However, it is not persistent in cultivated fields. The most aggressive of the native weeds is Marsh Elder, (*Iva xanthiifolia*) though extending eastward to the Mississippi River it is not important in the Eastern states, it partially takes the place of the Large Ragweed in the Missouri Valley, the Red River of the North and in Manitoba. This weed illustrates how a plant common in the alluvial flood plains soon adapts itself to cultivated areas. The older settlers of Manitoba always found it near buildings occupied by half-breeds but presumably also by other untidy farmers, and hence have given it the name of "half-breed weed."

The Yarrow, an indigenous plant, is abundant throughout the region from Winnipeg to Seattle, although rarely troublesome in fields. The Greater Ragweed, (*Ambrosia trifida*) one of the most conspicuous weeds in the Northern Mississippi Valley, is fairly common in the southern part of Manitoba to Winnipeg, St. Vincent, Minnesota, and Pembina, North Dakota. Outside of the Province of Manitoba it is a rare weed. The Hog-weed or Bitter-weed (*A. artemisiaefolia*) is still rarer, but the perennial *A. psilostachya* is not infrequent in Minnesota and in gravelly knolls of Iowa, and is a fairly common native plant on the plains about Winnipeg, westward it is not common, though common in the United States east of the Rockies. The common Mayweed (*Anthemis Cotula*) and Burdock (*Arctium major*) of Iowa, Wisconsin and Minnesota, are comparatively rare in the Northwest territory but more frequent on the west slope of the Rockies in British Columbia, Washington, Oregon and Utah. This is particularly true of the Burdock. The indigenous biennial Wormwood (*Artemisia biennis*) is quite as common in Manitoba as in Minnesota, while the European Wormwood (*Artemisia vulgaris*) is a common plant along roadsides in Manitoba. The European Mugwort, (*Senecio vulgaris*) seldom seen in the Northern Mississippi Valley states, is common in places in Manitoba, on the Pacific Coast, Vancouver Island and Seattle in Washington. In the recent edition of Gray's Manual Robinson and Fernald note that



Ragweed or Kinghead (*Ambrosia trifida*) common roadside weed. Texas to Canada, especially common from Iowa to North Dakota.



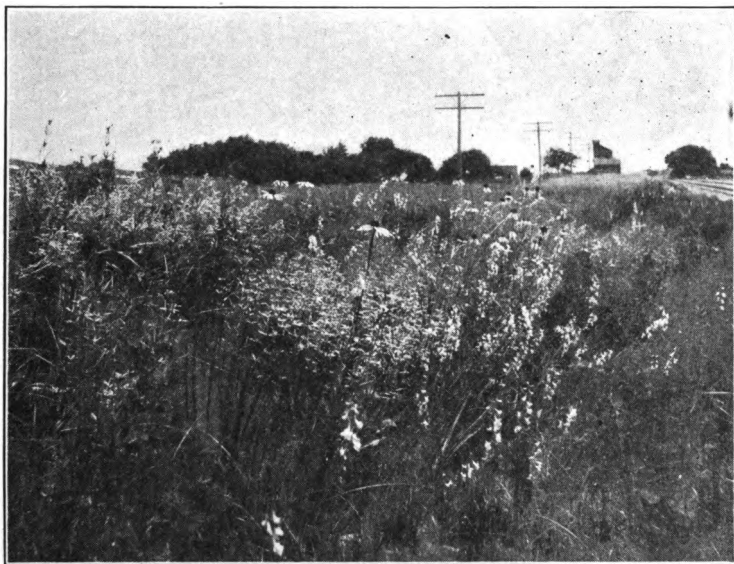
Cirsium canescens, common from western Iowa to the Rockies, north to Alberta.

is common in waste places in the east. The common Bootjack found everywhere in Wisconsin, Iowa, Minnesota, eastern Nebraska and Missouri, in fields and along roadsides, is less abundant in Manitoba. It is rare westward in Canada and only local in the Rocky Mountains. The Bachelor's Button (*Centaurea cyanus*) is not uncommon on the Pacific Coast, especially in California. In the Mississippi Valley it is rare except as an escape from gardens, although Dr. Robinson states that it occurs along roadsides. The yellow-flowered Knapweed or Barab's Weed (*C. solstitialis*) has been reported from several different points in Iowa, but abundant on the Pacific Coast, largely introduced here with alfalfa seed from the west. Several other species have been naturalized on the Pacific Coast. The Ox-eye Daisy (*Chrysanthemum leucanthemum*) was found along the railway near Sicamous Junction, B. C., and near Seattle, Wash. The roadside looked like an eastern roadside. In the East Ox-eye Daisy is recognized as one of the most common and troublesome weeds in pastures and meadows. In Iowa it rarely causes any trouble, for 15 years a small patch has been found along the right of way of the C. & N. W. Railway in Story county, but it has not, however, made much advancement to neighboring fields. Here and there in Wisconsin and Minnesota there are isolated patches but with little tendency to spread. We are told by Dr. Fernald of Harvard University that it is confined to a small area in eastern Canada and that our common plant is something entirely different.

Chicory (*Cichorium Intybus*) was not observed east of the Rockies in Canada but abundant west in British Columbia and Washington. It is abundant locally in Wisconsin and Minnesota and has become widely scattered in Iowa with clover and alfalfa seed in recent years, but nowhere abundant. The Thistles are not numerous in species but abundant. The Canadian Thistle (*Cirsium arvense*) has made its way across the continent from Winnipeg west to Vancouver Island and Seattle. It has become naturalized at numerous points, Winnipeg, Winnipeg Beach, Emerson, Moose Jaw, Calgary, Portal, North Bend, (B. C.) Bremerton, Everett, Seattle, Washington. It has spread extensively in Manitoba, occurring in fields, meadows, along roadsides and even occurring in woods. It is not unlikely that it will be as common in the other provinces of Northwestern Canada as it now is in Manitoba. It seeds freely in Manitoba. The climatic conditions seem to be much more favorable in Canada than Iowa. It has occurred for a much longer time in Iowa than in Manitoba, but it is not a dominant weed as in the Canadian Province. The plant occurs in many counties, if not in every one. Perhaps in many of the Minnesota and Wisconsin counties. It is more

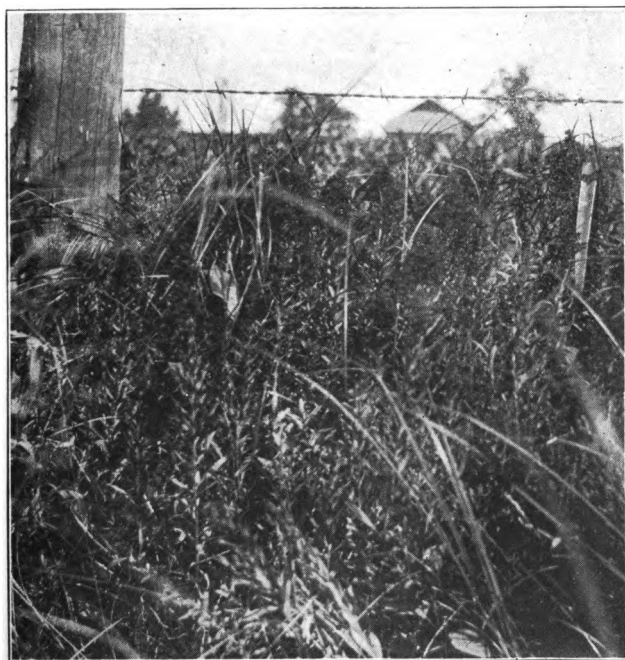
abundant in Northern Iowa than in the southern part of the state. For many years the plant rarely produced seed in this state, though the seed was not infrequently produced on plants found along the shores of Lake Michigan in Wisconsin. It now seems to have developed the seed habit in Iowa, though by no means as frequent as in Canada and in Europe. The Woolly Thistle (*Cirsium canescens*) indigenous to the country and to the south to western Iowa to the Rocky Mountains in Colorado and Montana, is common east of Calgary. The Field Thistle (*Cirsium discolor*) though a common weed in Iowa and Minnesota, is less common in the Red River Valley and only reaches across the border into Manitoba. The Bull Thistle (*Cirsium lanceolatum*) is not common at any point east of Calgary to Winnipeg but on the west slope of the Rockies in the valleys of the Selkirks and Cascades to Vancouver, Victoria, (B. C.) Seattle, Everett and Seattle it is a common weed. It is common also in the Great Basin Country of Utah and in Montana and Idaho. The White Weeds, (*Erigeron ramosus* and *E. strigosus*) so common everywhere in the Mississippi Valley from Missouri north to Minnesota and west to Nebraska, are not to be counted among the conspicuous weeds of that country. The Horseweed, which is sometimes called the Maretail, is not abundant in the great wheat belt of Canada, although in British Columbia it is abundant in clearings and cultivated fields. The White Weeds give an interesting aspect to the meadows in Iowa in June.

The common weedy Sunflower *H. petiolaris* and the *H. annuus* are less frequently found on the Pacific Coast, but common in Kansas and Nebraska westward to the Rockies. On the prairies about Winnipeg west to Moose Jaw and Medicine Hat the *H. maximilianii* is abundant. This species also occurs in Northwestern Iowa through Minnesota to Manitoba. The Blue Lettuce (*Lactuca pulchella*) is abundant about Winnipeg and southward but not abundant in Saskatchewan and Alberta, common from western Iowa and westward. Prickly Lettuce (*Lactuca Scariola*) is common from Kamloops to Victoria and Seattle, and on the Pacific Coast in California and eastward. In some places more common than the variety *integra* which is the common form in the Mississippi Valley. The species is rare in Iowa, although the variety is abundant. The rapid spread of the variety in Northern United States since 1877 shows how remarkably well it has adapted itself to the more humid and drier regions of the country. The Pine-apple Weed (*Matricaria suaveolens*) is common from Sicamous Junction, Revelstoke, B. C., to Victoria, Vancouver, B. C., and Seattle. This weed is common on the Pacific slope, throughout the interior of the continent in



WEEDS OF THE PRAIRIE. IOWA.

Morning Glory (*Convolvulus sepium*).
 Larkspur (*Delphinium carolinianum*).
 Goldenrod (*Solidago canadensis*).



Goldenrod (*Solidago canadensis*), Aster, and other weeds during the month of September. Iowa.

Utah and Idaho and according to Robinson and Fernald is locally abundant in New Brunswick, New England, New York and Pennsylvania and about St. Louis. Here we have a most aggressive Pacific slope weed which has adapted itself to a wide scope of territory. It is one of the few Pacific slope weeds which has thus extended its territory eastward.

The Goldenrods are poorly represented in Northwestern Canada. The Missouri Goldenrod (*Solidago missouriensis*) is common in Southern Manitoba to Winnipeg Beach and westward, but scarcely weedy. The *S. rigida* occurs in Manitoba but not a common plant. A very common weed in Iowa pastures. The Canadian Goldenrod (*S. canadensis*) is common in Illinois, Wisconsin, Missouri, Nebraska and Minnesota, often weedy in pastures and along roadsides but seldom so in Manitoba. It occurs, too, on the west slope of the Cascades near North Bend and elsewhere. The Sow Thistle (*S. oleraceus*) occurs in Winnipeg, more frequent on the Pacific Coast, Seattle and elsewhere, on the other hand, the perennial Sow Thistle (*S. arvensis*) is abundant everywhere in Manitoba from Emerson to Winnipeg and westward through the older settled portion of Manitoba. Some fields and pastures are yellow with its flowers. It is spreading about St. Vincent, Minnesota, and Pembina, and other parts of North Dakota. It is rare in other Northern Mississippi Valley states. It is one of the greatest pests of the Canadian wheat field. A field covered with it is not productive unless the summer fallow method is pursued, and this is an expensive operation and not economic where the one crop method is followed.

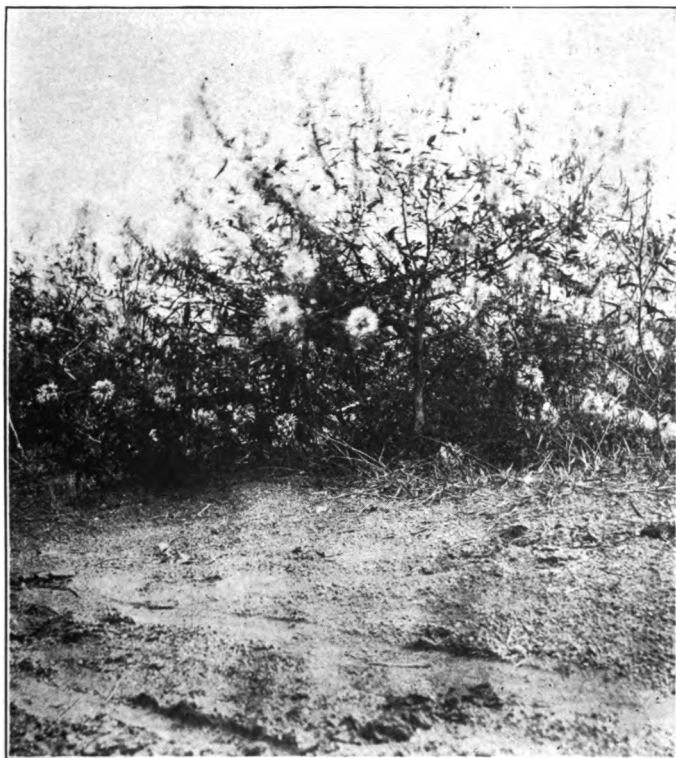
The Dandelion (*Taraxacum officinale*) is common everywhere from Winnipeg to the coast, south to Seattle. The Cocklebur (*Xanthium canadense*) from Minnesota to Texas and even in cultivated fields of the Colorado Rockies, so common to the south can scarcely be regarded as a very troublesome weed in Canada, although found about Winnipeg and Winnipeg Beach, and west to Moose Jaw. A most troublesome weed in the corn belt region.

The Cat's-ear (*Hypochaeris radicata*) which is naturalized from Europe and a ballast weed along the Northern Atlantic Coast, does not occur in the Northern Mississippi Valley; it is one of the most common weeds in lawns and in waste places from Oregon to Vancouver and the Vancouver Island. There is a common impression in Oregon that this weed was introduced in that state from Chili. A related species *H. glabra* is naturalized in California and occurs sparingly in Maine. The Hawkbit (*Leontodon autumnalis*) is common in the eastern states and in Ontario but has not found its way to the Northern Mississippi Valley. The Goat's Beard (*Tragopogon pratensis*) is a common plant in the

Rocky Mountains and along irrigation ditches and in fields in the eastern states. It rarely occurs in Iowa. The *T. porrifolius* also occurs in the Rocky Mountains. The Galinsoga (*Galinsoga parviflora*) of tropical America was first observed by the writer in Missouri near hotbeds and greenhouses in 1886. It had made its way northward to Wisconsin in 1903, and was observed in Iowa about the same time. It has spread to Utah and adjacent regions. Generally found near hot beds and greenhouses.

A few weeds of the *Cruciferae* are widely distributed in the older cultivated portions of the Northwest, especially in Manitoba. The common Mustard (*Brassica arvensis*) is one of the most common weeds of grain fields and associated with it, but somewhat more widely scattered, the Penny-cress or Stink Weed (*Thlaspi arvense*) should be mentioned. This weed is common throughout the provinces of Saskatchewan, Alberta, and Manitoba, less frequent in British Columbia. It occurs along railways and it is abundant also in the grain fields of the Dakotas and Minnesota but less frequent in Iowa. Not infrequent in Utah to Montana and Washington. Its spread in Canada is attributed to seed and hay. The Black Mustard (*Brassica nigra*) is less frequent than Charlock. It is common in Iowa. The *Brassica campestris* is more frequent on the coast in Vancouver, Washington and Oregon. The Shepherd's Purse (*Capsella Bursa-pastoris*) is common from Winnipeg to the coast, south to Texas, the Rocky Mountain region and to the Atlantic coast. It is more abundant in the north than in Iowa because of the cooler climate.

The Small Pepper Grass (*Lepidium apetalum*) is common from Winnipeg to the mountains, though more frequent in Manitoba than westward. It, however, has spread westward through British Columbia south to Washington. It is a common weed throughout the Mississippi Valley from Missouri to Kansas to the Dakotas east to Wisconsin. Dr. Robinson says "perhaps native in the west, recently introduced eastward." It is certainly the common species in the west; the larger Pepper Grass (*L. virginicum*) is common southward, rare northward and not observed in Canada. Of the Hedge Mustard (*Sisymbrium*) the latest of the European immigrants, the Tumbling Mustard (*Sisymbrium altissimum*) which has had but a comparatively short history in this country, is frequent in many parts of Minnesota, North Dakota through Montana to Washington and to the south in Utah, and parts of Colorado and occasionally in Iowa. It is abundant in the provinces of Manitoba, Saskatchewan, Alberta, and British Columbia, occurring everywhere along railroads and in grain fields. The *Berteroa incana* is a recent introduc-



Cleome (*Cleome serrulata*) common from western Iowa introduced eastward to the Pacific, Alberta, and Saskatchewan.

tion with clover seed. The Hare's Ear Mustard (*Conringia orientalis*) of grain fields is a recent introduction. The Horseradish (*Radicula Armoracia*), Marsh Cress (*Radicula palustris*) and Winter Cress (*Barbarea vulgaris*) have long been known as troublesome weeds of the north. The Common Hedge Mustard (*S. officinale*) is not common in the province east of the Rockies though common in Iowa, Wisconsin and Minnesota. It is much more common on the Pacific coast from Seattle to Victoria, Vancouver east to Sicamous Junction and Revelstoke. Several native species occur in eastern provinces, like *S. cummunis* and *S. incisum*, the latter a mountain species. These along with the False Flax (*Camelina sativa*) make up the more important weeds of this family. The *Camelina* occasionally occurs in Iowa and is frequently found in Minnesota. Of the family *Capparidaceae*, only one species occurs in the Canadian region, namely *Cleome integrifolia*. Introduced near St. Paul and other parts of eastern Minnesota and occasionally in Central Iowa. Indigenous to Western Iowa and abundant in Nebraska westward through Colorado, Utah and Nevada and north to eastern Washington and east to the Dakotas. It is fairly common in Saskatchewan and Alberta, less frequent in Manitoba. It is rare in British Columbia except the more arid portions about Kamloops and Ashcroft.

The only common weed of the *Convolvulaceae* in Manitoba is the Morning Glory (*Convolvulus sepium*) extending west to Moose Jaw. It is most frequent about Emerson, Manitoba, Pembina, North Dakota, and St. Vincent along the Red River; frequent in Minnesota, Wisconsin, Iowa, Illinois, Nebraska, Kansas and Missouri and eastward. The European Bindweed* (*Convolvulus arvensis*) of Europe long known as a troublesome weed in the east and on the Pacific Coast, widely scattered as an ornamental plant and has become a troublesome weed in Missouri and here and there in Iowa, does not occur in Manitoba or westward to the Rockies, but again on the Pacific coast from Vancouver to Oregon. In the south a number of species of Morning Glory are troublesome like the common Morning Glory (*Ipomoea purpurea*) and the white and purple or pale blue flowered annual Morning Glory (*I. hederacea*) common in corn fields and springing up abundantly after the grain is cut. The perennial Man-of-the-Earth (*I. pandurata*) with fiddle-shaped leaves and white flowers is occasionally troublesome in corn fields. Mention should be made of the Dodders (*Cuscuta*). The Flax Dodder (*C. Epilinum*) in the northwest, the Field Dodder (*C. arvensis*) on clover in Iowa, Wisconsin and eastward, and the Clover Dodder in the alfalfa growing sections of the west. The common Mullein (*Verbascum Thapsus*) is common in Minnesota and Iowa, although certainly not common in Mani-

toba west to the Rockies, common, however, west of the Rockies in British Columbia, Seattle, and other points in Manitoba. The *V. Blattaria* common eastward in Utah and the Pacific coast.

The Foxglove (*Digitalis purpurea*) frequently cultivated as an ornamental plant on the coast, is a frequent escape and one finds patches of the escaped plants frequent in Oregon, Washington, and western British Columbia. The Toadflax (*Linaria vulgaris*) is common east and north. I might mention here, also, that the *Linaria Cymbalaria* of the same family, and common Pansy (*Viola tricolor*) of the *Violaceae*, is an escape from cultivation in Washington and Oregon. The Petunia, Dianthus, Phlox, objects of careful cultivation, are more or less weedy in Washington and Oregon.

A few weeds of the Goosefoot Family, *Chenopodiaceae*, are widely distributed in the northwest. The Russian Thistle (*Salsola Kali* var. *tenuifolia*) which at one time threatened to spread over the corn belt as it was injurious in the wheat belt of the Dakotas and the Northwest is abundant in some localities, along the right of way of railways and sandy soil in Minnesota, Wisconsin and Iowa, and common along railways and locally from Winnipeg west to the coast although not nearly as frequent as it is in Colorado, Utah and the drier regions of the west to the coast where it has found a congenial home. The common Lamb's quarter (*Chenopodium album*) is common across the continent from St. Paul to Seattle and from Omaha to Salt Lake and from Winnipeg to Vancouver. It follows the railways across the continent. The species was found in Banff, Sicamous Junction and Crow's Nest Pass, more abundant in southern Manitoba and in Minnesota than in Alberta and Saskatchewan. The Large Goosefoot (*Chenopodium hybridum*) common in Minnesota and Winnipeg and Winnipeg Beach and in many places of Minnesota, Wisconsin, Missouri and Illinois. The *Chenopodium glaucum* found rather common about the great lakes also occurs in Winnipeg and Winnipeg Beach, where it is common.

The Western Pigweed (*Monolepis Nuttalliana*) is common in Saskatchewan and Manitoba, it is of more frequent occurrence in fields than the common Goosefoot and more abundant than the Russian Thistle in that region. It has not reached Iowa although found in Minnesota and reported from Missouri by Robinson and Fernald. It occurs in all of the provinces from Winnipeg to British Columbia.

The species of weeds of the Pink Family, *Caryophyllaceae*, are not numerous. The Cowherb (*Saponaria Vaccaria*) occurs in the wheat growing section of the northwest frequent in Minnesota and Dakota.

abundant also in the wheat growing sections of the country north and south, though generally closely associated with wheat it is not always so. In the Great Basin of Utah it is frequently found in dry places on banks in the Cache Valley in Utah. The Corn Cockle (*Agrostemma Githago*) has a similar distribution. The Bouncing Betty abundant about St. Paul and Minneapolis, and northeastern Iowa and is widely scattered but never abundant in other sections of the state, in British Columbia, especially near Victoria, Vancouver, North Bend and in western Washington it is abundant. The Night-flowering Catchfly (*Silene noctiflora*) which has been a weed of gardens for thirty years in the state of Wisconsin, has become widely diffused in Illinois and Missouri and other clover growing states of the west because of the large importation of clover seed from Europe and the eastern states where the weed is common. It was not observed in Manitoba or elsewhere in western Canada. The Catchfly (*Silene dichotoma*) related to the Night-flowering Catchfly, has become common in clover fields from New England to Iowa and Texas. The Ragged Robin (*Lychnis Flos-cuculi*) and the White Catchfly (*L. alba*) occur under similar situations but less frequently. The *Cerastium vulgatum* is common in pastures in some parts of Iowa and on the Pacific coast, Victoria, Vancouver, and Seattle, Washington. The Nodding Chickweed (*Cerastium nutans*) is common in fields in Missouri, Illinois and southern Iowa. The common Chickweed (*Stellaria media*) on the other hand is a common garden and lawn weed from Minnesota, Emerson, Winnipeg, Winnipeg Beach, Manitoba, on the west slope as Sicamous, Vancouver, and Victoria and in the state of Washington, Seattle and Everett, and a common weed in the northern Mississippi Valley to the Atlantic coast and in the Rocky Mountains. It is now spreading rapidly in shaded lawns in many parts of Iowa.

The common Purslane or Pusley (*Portulaca oleracea*) has been more weedy in New England since the beginning of the eighteenth century. It has been a common weed in the Mississippi Valley since the early agricultural settlements. Now is common in gardens and cultivated fields. It is also common in the Rocky Mountains country and on the Pacific coast and the Gulf states.

The Pigweeds so common and weedy in the northern Mississippi Valley states are not abundant in the northwest. The common Pigweed (*Amarantus retroflexus*) was common in St. Vincent, Minnesota, Emerson, Manitoba, but was rare in Winnipeg, more common on the west slope of the Rockies, Kamloops, Victoria and Vancouver. The *Amarantus graecizans*, the common Tumbleweed of Iowa, is not common in Manitoba and

the other provinces east of the Rockies. It occurs in some of the irrigated fields near Kamloops.

Of the Dogbane Family (*Apocynaceae*) none of the species are especially weedy in Manitoba and westward, though the *Apocynum cannabinum* is a most troublesome weed in Iowa and Minnesota. It is also a weed in the Rocky Mountain states. Of the Milkweed Family (*Asclepiadaceae*). The common Milkweed (*Asclepias syriaca*) occurs occasionally in southern Manitoba and less so in the Saskatchewan, though it is one of the most common weeds in Iowa and Minnesota. Of the family *Urticaceae*, one weed is common from Kentucky north to Minnesota and Wisconsin and west to the Rockies and in the great basin country, namely the common Hemp (*Cannabis sativa*) which has largely spread from cultivated fields of the plant and its use as a bird seed. The Nettles, especially *Urtica gracilis* and *U. dioica* are common northward in Wisconsin and Minnesota, though not abundant in Iowa, found also in the Rocky Mountains in British Columbia and Manitoba. In the great basin, Salt Lake Valley, the western *U. holosericea* has taken its place.

Of the family *Umbelliferae*, I saw no introduced weeds, though doubtless *Pastinaca sativa* and *Daucus carota* occur in Manitoba, both occur in British Columbia and in Washington. Both of these are common roadside weeds in the northern Mississippi Valley and eastward. The Wild Carrot is abundant in clover fields in the east. It is disseminated with clover seed. The *Cicuta maculata* is common in Saskatchewan and Manitoba.

Of the *Malvaceae* one weed is fairly common in southern Manitoba. Common Cheeses (*Malva rotundifolia*). It is likewise common on the Pacific coast in Washington and British Columbia. A second species *M. crispa* is local in the Northern Mississippi Valley. The Evening Primrose (*Oenothera biennis*) of the Primrose Family *Onagraceae*, in its various forms is common on the Pacific coast, Washington and British Columbia and more or less common in Saskatchewan and parts of Manitoba. The Fireweed (*Epilobium angustifolium*) is common everywhere in the Rockies and easily takes the front rank as a weed in the forest clearing in British Columbia and Washington.

Comparatively few of the *Labiatae* are troublesome weeds in Canada; Self-heal (*Prunella vulgaris*) is common on the Pacific coast and in the wooded districts of eastern Manitoba, elsewhere it is not common and occurs from Missouri to Minnesota. Occasionally one sees *Teucrium canadense* in southern Manitoba common from Missouri to Minnesota and Nebraska. On the west slope of the Rockies to the Pacific coast a

Dead Nettle (*Lamium album*) is weedy. In Missouri and Illinois and eastward the *L. amplexicaule* is an early spring weed. The Hemp Nettle (*Galeopsis Tetrahit*) is common in British Columbia near Sicamous Junction.

There are but few weedy plants of the family *Leguminosae*. The Wild Licorice (*Glycyrrhiza lepidota*) is common everywhere on the prairies of Minnesota to Winnipeg west to the provinces of Saskatchewan and Alberta, but less frequent on the west slope, abundant in the Rockies to the great basin. The two species of Sweet Clover (*Melilotus alba* and *M. officinalis*) are common in parts of Minnesota and on the west coast. The former occurs near Winnipeg but is rare in the provinces to the west, east of the Rockies in Canada. Though both species are common in the Rockies south of the boundary, west to Utah, Idaho, and Washington. The Common Vetch (*Vicia sativa*) is common in the grain fields of northern Iowa, Wisconsin, and Minnesota, less frequent in the grain fields of Alberta.

The common Plantain (*Plantago major* and *P. Rugelii*) of the Plantain Family (*Plantaginaceae*) are common everywhere in the Northern Mississippi Valley, in Manitoba but less frequent westward. Common on the coast. It is likewise common in Washington. The Buckhorn (*Plantago lanceolata*) which has been widely distributed in recent years with clover seed in Iowa, occurs throughout the northern Mississippi Valley states and was observed in LaCrosse in 1897. It was not observed in the Northwest provinces, probably largely because clover is not a common crop and the seed is generally distributed with clover seed. It does, however, occur on the Pacific coast, Vancouver, British Columbia, Washington and Oregon. The Dooryard Knotweed (*Polygonum aviculare*) of the *Polygonaceae* is the most widely distributed of the genus, common throughout the northwest from Minnesota to the Rockies south to Colorado and west to Utah to the Pacific Northwest. It is common also in Manitoba from Winnipeg and Winnipeg Beach to the coast. The plants are much more robust than the plant of Iowa. The Wild Buckwheat (*P. Convolvulus*) commonly found in grain fields of the northern states is as yet not common in the Canadian provinces. The Smartweed (*P. Persicaria*) a roadside weed of the northern states is less frequent in the Canadian provinces although occurring as far north as Winnipeg Beach and Emerson and common everywhere from the great basin to the Atlantic coast. The Prince's Feather or Smartweed (*P. pennsylvanicum*) is a common plant in Iowa and Minnesota corn fields but it is a rare plant near the boundary.

There are few weeds of the Rose Family. The Silver Weed (*Potentilla anserina*) is common in Manitoba and provinces westward, especially in alkali impregnated soils. The Common Fivefinger (*P. monspeliensis*) is not common in the northwest provinces but common in the northern and eastern states. The Western Fivefinger (*P. dissecta*) is also common in the northwest especially westward.

Of the *Verbenaceae* there are no common weeds in Manitoba to the Pacific coast. Three species are troublesome in Iowa and Minnesota, the *Verbena stricta*, *V. hastata*, and *V. urticaefolia*, and the *V. bracteosa* is a common roadside weed in the Mississippi Valley and eastward.

Weed migration is an interesting problem and the northwest is of particular interest because a virgin soil is being turned under to produce agricultural crops. What weeds will succeed best in a country with the climate and rainfall of Canada should be followed up by the Canadian botanists.

Dr. C. H. Shaw¹ in an interesting communication on "The Causes of Timber-line on Mountains," shows how through human agencies in the Alps of Switzerland, the vegetation has become changed in a very marked degree. The whole aspect of our prairie flora in Iowa is changing and before many years that of the northwest will be very different from its character today.

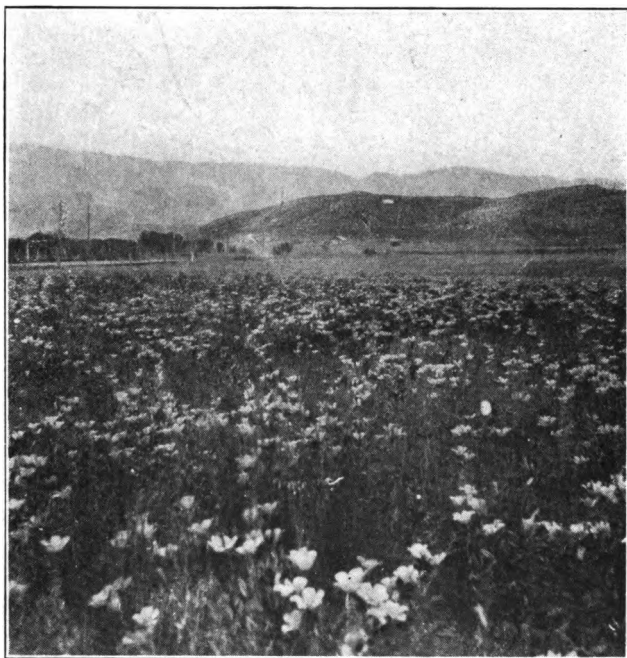
¹Plant World 12: Aug. 1909.



The Meadow Sunflower (*Helianthus grosse-serratus*) common in the lowlands of the Northern Mississippi Valley.



Yarrow (*Achillea Millefolium*) the common pasture weed of Northern United States and Canada, the Rockies to the Pacific.



A meadow of the Texas Lily (*Eustoma Russellianum*) in a field, Colorado. Common from Texas to Nebraska and Colorado.

PRELIMINARY LIST OF THE PARASITIC FUNGI OF FAYETTE COUNTY, IOWA.

BY GUY WEST WILSON.

That northeastern Iowa is a rich field for the mycologist is well known to those in any degree acquainted with the work of Prof. Holway while a resident of Decorah. From this region came numerous new species and here was gathered much information concerning others already known. While from its nearness to Decorah the region about Fayette cannot offer such facilities for pioneer work as did Decorah, yet it is a most excellent base from which to study the mycological flora of this section of Iowa. Lying as it does on the borderland between the Transitional and Upper Austral zones and midway between the plains of the west and the forests of the east this section of the state is a strategic point, so to speak. It was, therefore, with no small pleasure that I looked forward to my field work in this region. The results have far excelled my expectations.

The region is a rolling prairie, traversed here and there by streams, chief of which are the Turkey and the Wapsipinnicon rivers with their tributaries. About four-fifths of the county is drained by the former, which crosses it in the northern part. The central portion of the county is drained by the Volga river, a tributary of the Turkey. The southern border and southwestern corner of the county are drained by the Wapsipinnicon. These streams are skirted by more or less pronounced belts of timber. There is, consequently, a great diversity of the soil and shade factors which influence the development of the flora of the region, the lower as well as the higher plants.

The greater part of the field work was confined to the region about Fayette, but a short trip was made to Dover township, and a few species were collected near Oelwein. The time employed was the autumn of 1907, the spring and autumn of 1908, and the season of 1909. The present list contains all the species which have been determined up to the present time, but a considerable bulk of unidentified material has also accumulated. The number of species here recorded is two hundred and forty-five—but twenty-three less than the total of Dr. Trelease list of

Wisconsin species, and within sixteen of the number recorded by Dr. Underwood for Indiana.*

The only previous publications devoted to the parasite fungi of Fayette county are two papers by Dr. Bruce Fink* in which he enumerates the *Erysiphaceae* collected by him. According to the arrangement followed by Salmon and adopted by Anderson† the total number of forms was twenty-one infecting fifty-four hosts. The larger part of these were recollected and additions made to the list. The hosts common to both my own and Dr. Fink's collections have been marked with a star (*) while those species which were not recollected are included without a serial number and the additional hosts given in the notes under the various species.

While consistency has not been attempted in the matter of nomenclature the species are named in accordance with the later available literature of the various groups. The *Erysiphaceae* follow Anderson's paper in the use of Salmon's classification, although some of his conclusions do not appeal to me as satisfactory disposition of certain forms. The order *Moniliales* is treated in accordance with Pound and Clement's "Rearrangement of the North American Hyphomycetes."** This eliminates *Dematiaceae* from consideration, placing all the forms usually considered as belonging to this family in *Moniliaceae*. The families differ only in color, a character which has been shown to be a matter of nutrition more than an inherent character of taxinomic importance. This arrangement brings the closely related genera *Didyminium*, *Ramularia*, and *Cercospora* in close proximity and eliminates *Cercosporella* for the light colored species of *Cercospora*. The *Uredinales* follow the classification of Dr. Arthur's monograph† in so far as it is available. This causes a division of certain genera of the *Melampsoraceae* and the removal from *Puccinia* and *Uromyces* of certain species which show a closer relationship with *Ravenelia*. The nomenclature of hosts is that of the seventh edition of Gray's Manual, with citations in the several instances of such names as are not the same in Britton's Manual. Under each species are given such notes on appearance, frequency, and abundance as might be of interest to mycologists, or of assistance to the student who is interested

*Trelease, Trans. Wis. Acad. 6: (1-40). 1884. (268 species.)

Underwood Proc. Indiana Acad. Sci. 1893:30-67. 1894. (261 species of parasitic Fungi.)

*Blights, Orchids, and Ferns of Fayette, Iowa. Bull. Upper Iowa Univ., Jan. 1894. Additions to Iowa Flora Proc. Iowa Acad. Sci. 14:103, 104. 1893.

†Proc. Iowa Acad. Sci. 14:15-46. 1907.

*Minn. Bot. Studies 1:644-673, 726-738. 1896-97.

†North American Flora. 7:83-169. 1907.

in these forms. At the conclusion of the list is a host index, which includes cross references to the synonymy of the hosts. Such synonyms have been cited for the species as the name employed might make necessary, and where the name employed by Greene in his "Plants of Iowa" is not the same.

In conclusion I wish to express my hearty appreciation of the kindness of Dr. J. C. Arthur in verifying my determination of the Uredinales, and for suggestions in this group.

CLASS PHYCOMCETES.

ORDER CHYTRIDIALES.

Family *Synchytriaceae*.

1. *SYNCHYTRIUM AECIDIODES* (Peck) Wilson & Seaver. [*Uredo aecidioides* Peck; *S. fulgens decipiens* Farlow.]

On *Amphicarpa monoica* (L.) Ell. and *A. Pitcheri* T. & G. (Falcata Kuntze.)

Our commonest species of the genus. The yellow sori which are borne in great profusion on leaves, stems, and immature fruits of the host renders the infected plants quite conspicuous. Very abundant upon the first host, but sparingly on the second.

2. *SYNCHYTRIUM ANEMONES* (de Bary & Woronin) Woronin.

On *Anemone quinquefolia* L.

The purple sori of this species are quite abundant on stems and leaves, especially along the veins. This host is infested with several fungi two or three of which frequently are associated, in the present instance the commonest one being *Urocystis anemones*. The epidermal covering of the smut serus is frequently covered with an abundance of the galls of the *Synchytrium*.

3. *SYNCHYTRIUM FULGENS*. Schröter.

On *Oenothera biennis* L. (Onagra Scop.)

A single rosette was found infected with this fungus late in May.

4. *SYNCHYTRIUM HOLWAYI* Farlow.

On *Monarda fistulosa* L.

A conspicuous species owing to the stunting and slight hypertrophy of the host and the bright purple color of the galls. First noted about the middle of July.

ORDER ENTOMOPHTHORALES.

Family *Entomophthoraceae*.

5. *ENTOMOPHTHORA MUSCAE*. (Pers.) Fries.

On *Musca domestica* L.

The cause of a considerable mortality among house flies in the late autumn.

ORDER PERONOSPORALES.

Family Albuginaceae.

6. ALBUGO BLITI (Biv.) Kuntze. [*Cystopus Bliti* (Biv.) de Bary.]

On *Amaranthus graecizans* L. and *A. retroflexus* L.

7. ALBUGO CANDIDA (Pers.) Roussel.

On *Brassica nigra* (L.) Koch, *Lepidium apetalum* Willd., and *Radicula palustris* (L.) Moench. (Roripa Bess.)

The commonest of our white rusts.

8. ALBUGO PORTULACAE (DC.) Kuntze.

On *Portulaca oleracea* L.

Common throughout the growing season.

9. ALBUGO TRAGOPOGONIS (DC.) S. F. Gray [*Cystopus cubicus* Lev.]

On *Ambrosia artemisiaefolia* L.

A widespread and variable species with numerous hosts, but locally neither common nor abundant.

Family Peronosporaceae.

10. SOLEROSPORA GRAMINICOLA (Sacc.) Schröter. [*Peronospora graminicola* Schröter.]

On *Setaria glauca* (L.) Beauv. and *S. viridis* (L.) Beauv. [*Chaetochloa* sps. Scribn.]

Not abundant, the oospores being found sparingly in the autumn.

11. RHYSOTHECA AUSTRALIS (Speg.) G. W. Wilson [*Peronospora australis* Speg.]

On *Echinocystis lobata* (Michx.) T. & G. (Micrampelis Greene.)

A single infected vine was found in Dover Township late in August.

12. RHYSOTHECA GERANII (Peck) G. W. Wilson [*Peronospora Geranii* Peck.]

On *Geranium maculatum* L.

About half a dozen infected leaves found in early summer.

13. RHYSOTHECA HALSTEDII (Farlow) G. W. Wilson [*Peronospora Halstedii* Farlow, *Plasmopara Halstedii* Berl. & De-Toni.]

On *Ambrosia artemisiaefolia* L., *A. trifida* L., *Bidens comosa* (A. Gray) Wiegand, *B. frondosa* L., *Eupatorium purpureum* L., *Helianthus doronicoides* Lam., and *Lepachys pinnata* (Vent.) T. & G. (Ratbida Barnhart.)

A common and variable species with a very wide range of hosts.

14. RHYSOTHECA ABDUCENS (Schröter) G. W. Wilson. [*Peronospora obducens* Schröter.]

On *Impatiens biflora* Walt.

Found sparingly once in midsummer.

15. RHYSOTHECA VITICOLA (B. & C.) G. W. Wilson. [*Peronospora viticola* de Bary, *Plasmopara viticola* Berl. & De-Toni.]

On *Vitise vulpina* L.

Probably the most abundant species of the genus, growing especially luxuriantly on the common wild grape, all the green parts of which are affected. Upright shoots, much enlarge and bearing smaller fleshy leaves, both leaf and shoot densely covered with the fungus are not uncommon on trailing vines.

16. PLASMOPARA PYGMAEA (Unger) Schroeter. [*Peronospora pygmaea* Unger.]

On *Anemone canadensis* L., *A. caroliniana* Walt., *A. quinquefolia* L., and *Hepatica acutiloba* DC. (*H. acuta* Britt.)

Very abundant from early spring to midsummer, often associated with other fungi on *Anemone quinquefolia*.

17. PERONOSPORA ALTA Fuckel.

On *Plantago major* L.

Not abundant, appearing in midsummer.

18. PERONOSPORA ARTHRI Farlow.

On *Oenothera biennis* L. (*Onagra* Scop.)

First seen July 16, 1909, and abundant from then until frost. Practically every leaf of many fully developed plants were severely infected throughout the region about Fayette, but no infected rosetts were seen.

19. PERONOSPORA CALOTHECA de Bary.

On *Galium boreale* L.

So far as observed this species was confined to a few clumps of the host which grew in the open along the railroad, but in these localities the species was quite abundant in the early summer.

20. PERONOSPORA CHENOPODII Schlecht.

On *Chenopodium album* L., and *C. hybridum* L.

Not uncommon throughout the later summer. The present species has been confused with *P. effusa* from which it is quite distinct. The relationship of these species has been discussed elsewhere so that it is unnecessary to enter into details here.

21. PERONOSPORA ECHINOSPERMI Swingle.

On *Lappula virginiana* (L.) Greene.

While searching in early October for the perithecia of a powdery mildew two leaves were found infected with the present species. The collection is of more than ordinary interest as this is the most eastern station for the species, not to mention the fact that it has heretofore been collected only on narrow leaved hosts of the type of *L. Redowskiana*.

22. PERONOSPORA EFFUSA (Grev.) Rabenh.

On *Chenopodium album* L.

Abundant throughout the summer and autumn months.

23. PERONOSPORA EUPHORBIAE Fuckel.

On *Euphorbia maculata* L.

Common throughout the summer, causing a more erect habit in the host, but not having such a pronounced effect as the aecia of *Uromyces Euphorbiae*.

24. *PERONOSPORA HYDROPHYLLI* Waite.

On *Hydrophyllum virginicum* L.

A single collection was made June 11, 1908, the infection covering only a few leaves and not being abundant on these.

25. *PERONOSPORA PARASITICA* (Pers.) de Bary.

On *Dentaria laciniata* Muhl., *Draba caroliniana* Walt., *Erysimum parviflorum* Nutt., and *Lepidium apetalum* Willd.

Common and rather abundant, probably infesting a still greater number of hosts as it is to be looked for on almost every species of crucifer.

26. *PERONOSPORA POTENTILLAE* de Bary

On *Agrimonia mollis* (T. & G.) Britton, *Geum canadense* Jacq. and *Potentilla monsepalsensis* L.

Rather rare through the entire season.

27. *PERONOSPORA SORDIDA* Berk. & Br.

On *Scrophularia marylandica* L.

Not common, but where found rather abundant. Spring and early summer.

28. *PERONOSPORA TRIFOLIORUM* de Bary.

On *Astragalus canadensis* L. (*A. carolinianus* L.)

Rather abundant in early summer.

29. *PERONOSPORA VICIAE* (Berk.) de Bary.

On *Vicia americana* L.

Rather frequent during the early summer.

30. *BREMIA LACTUCAE* Regel. [*Peronospora gangliiformis* de Bary.]

On *Lactuca canadensis* L.

Neither common nor abundant. Midsummer.

CLASS ASCOMYCETES.

ORDER EXOASCALES.

Family Exoascaceae.

31. *EXOASCUS PRUNI* Fuckel.

On *Prunus americana* Marsh.

Not uncommon on wild plums causing the distorted fruits known as plum pockets.

32. *TAPHRIA COERULESCENS* (Mont. & Desm.) Schroeter.

On *Quercus rubra* L., and *Q. palustris* Moench.

Abundant in spring and early summer, causing yellowish or somewhat water-soaked blisters on the leaves of the oak.

33. *TAPHRIA JOHANSONII* Sadeb.On *Populus tremuloides* Michx.

Common on the immature aments of the aspen, causing a thickening of the capsule which is a very conspicuous object owing to the bright yellow color of the diseased tissue.

34. *TAPHRIA VIRGINICA* Sadeb. & Seym.On *Ostrya virginiana* (Mill.) K. Koch.

Causing a very conspicuous hypertrophy of the leaves of the host. Early summer.

ORDER PERISPORIALES.

Family *Erysiphaceae*.35. *SPHAEROTHECA HUMULI* (DC.) Burrill.On *Agrimonia gryposepala* Willr. (*A. hirsuta* Bicknell), and *Rhus glabra* L.

Not a common species, and not abundant on the hosts upon which it was collected. Reported by Fink on *Epilobium coloratum* Muhl.

36. *SPHAEROTHECA HUMULI FULGINEA* (Schlecht.) Salmon.

On *Erechtites hieracifolia* (L.) Raf., **Erigeron canadensis* L. (*Leptilon canadense* Britton), *Taraxicum officinale* Weber (T. *Taraxicum* Karst.), and *Veronica virginica* L. (*Leptandra* Nutt.)

Not uncommon on various weeds. Also reported by Fink on *Bidens frondosa* L., and *Sonchus oleraceus* L.

SPHAEROTHECA PANNOSA (Wallr.) Lev.Reported by Fink on *Rosa blanda* Ait.*SPHAEROTHECA MORS-UVAE* (Schw.) B. & C.

Reported by Fink on *Ribes cynosbati* L. and *R. rotundifolium* Michx. Conidia collected on *R. floridum* L'Her during the past summer may belong here.

37. *PODOSPHAERA OXYCANTHAE* (DC.) de Bary.On *Prunus americana* Marsh., and *P. avium* L.

Not uncommon on species of plum and cherry. Reported by Fink on an unidentified species of *Prunus*.

38. *PODOSPHAERA LEUCOTRICHA* (E. & E.) Salmon.On *Pyrus Malus* L. (*Malus Malus* Britton.)

Collected once on seedlings.

39. *ERYSIPHE POLOGONI* DC.On *Polygonum aviculare* L., *P. erectum* L., and *Ranunculus abortivus* L.

Abundant on various herbaceous plants. Reported by Fink on *Astragalus canadensis* L. (*A. caroliniana* L.), and *Oenothera biennis* L. (*Onagra* Scop.)

40. *ERYSIPHE CICHORACEARUM* DC.

On **Ambrosia artemisiaefolia* L., **A. trifida* L., *Aster cordifolius* L., *A. puniceus* L., *A. salicifolius* Ait., *Cirsium discolor* (Muhl.) Spreng (*Carduus* Nutt.) *Eupatorium urticaefolium* Reichard (*E. ageratoides* L. f.), *Helianthus*

doronicooides Lam., *Heliopsis scabra* Dunal, *Parietaria pennsylvanica* Muhl., *Plantago major* L., *P. Rugelii* Decn., **Verbena bracteosa* Michx., **V. hastata* L., *V. stricta* Vent., **V. urticaefolia* L.

Our commonest species of the family, infecting a wide range of herbaceous hosts and consequently showing considerable variability. Reported by Fink on *Ambrosia psilostachya* DC., *Aster laevis* L., *Aster sagitifolius* Willd., *Aster* sp. indet., *Helianthus annuus* L., *Phlox Drummondii* Hook., *Solidago canadensis* L., *S. rigida* L., and *S. serotina gigantea* (Alt.) A. Gray.

41. *ERYSIPHE GALEOPSIDIS* DC.

Conidia on *Mentha canadensis* L., and *Stachys palustris* L. are referred here. Reported by Fink on *Scutellaria lateriflora* L.

42. *ERYSIPHE GRAMINIS* DC.

On *Poa pratensis* L.

Not uncommon, especially the conidia. Reported by Fink on *Cinna arundinacea* L.

43. *MICROSPHAERA ALNI* (Wallr.) Winter.

On *Cornus alternifolia* L. f., **Corylus americana* L., **Lonicera Sullivantii* A. Gray, *L. tartarica* L., *Ostrya virginica* (Mill.) Willd., *Quercus velutina* Lam., **Syringa vulgaris* L., and *Viburnum lentago* L.

Common and usually abundant on a number of woody plants and quite variable, both in habit and character. Even upon the same host the mycelium may remain very conspicuous after the perithecia are mature or it may disappear completely. Reported by Fink on the following additional hosts: *Carpinus caroliniana* Walt., *Eonymus atropurpureus* Jacq., and *Ulmus americana* L.

44. *MICROSPHAERA ALNI EXTENSA* (Cooke & Peck) Salmon.

On **Quercus alba* L., and *Q. velutina* Lam.

Common on sprouts but not seen on full grown trees. Reported by Fink on *Q. rubra* L.

MICROSPHAERA GROSSULARIAE (Wallr.) Lev.

Reported by Fink on *Sambucus canadensis*.

45. *MICROSPHAERA DIFFUSA* Cooke & Peck.

On *Desmodium sessilifolium* (Torr.) T. & G. (*Meibomia sessilifolia* Kuntze). A single collection in Dover Township.

46. *MICROSPHAERA RUSSELLII* Clinton.

On **Oxalis stricta* L.

Not uncommon.

MICROSPHAERA EUHORBIAE (Peck) Cooke & Peck.

Reported by Fink on *Euphorbia corollata* L.

47. *UNCINULA SALICIS* (DC.) Winter.

On *Salix humilis* Marsh.

Very abundant. Also reported by Fink on an unidentified species of *Salix*.

48. *UNCINULA NECATOR* (Schwein.) Burrill.

On *Psedera quinquefolia* (L.) Greene (*Parthenocissus* Planch.), and *Vitis vulpina* L.

Rather common. Reported by Fink on *Vitis cordifolia* Michx. and an unidentified species of *Vitis*.

UNCINULA CIRCINATA Cooke & Peck.

Reported by Fink on *Acer saccharum* Marsh.

49. *UNCINULA MACROSPORA* Peck.

On **Ulmus americana* L.

Collected but once and then not over abundant.

UNCINULA CLINTONI Peck.

Reported by Fink on *Tilia americana* L.

50. *PHYLLACTINIA COBYLEA* (Pers.) Karst.

On *Fraxinus americana* L., and **Cornus stolonifera* Michx. (leg. Hungerford. *Xanthoxylum americanum* Mill (leg. Hungerford.)

While the collections of this species were rather scanty it appears to be rather a common species judging by Fink's long list of additional hosts which follow: *Acer saccharum* Marsh., *Betula papyrifera* Marsh., *Cornus florida* L., *Corylus americana* L., *Crataegus* sp. indet., *Fraxinus* sp. indet., *Desmodium grandiflore* (Walt.) DC. (*Melbomia grandiflora* Kuntze), and *Ulmus americana* L.

Family *Perisporiaceae*.51. *DIMEROSPORIUM COLLINSII* (Schw.) Thumen.

On *Amelanchier canadensis* (L.) Medic.

The entire under surface of the leaves is covered with the black perithecia. The fungus appears to be quite injurious to its host as it causes a pronounced falling of the leaves in late summer and early autumn. That the mycelium is perennial is indicated by the changed appearance of the infected twigs which grow quite luxuriantly, are thicker and brighter colored than the healthy twigs, besides showing a decided tendency in favor of forming witches brooms.

52. *DIMEROSPORIUM PULCHRUM* Sacc.

On *Cornus paniculata* L'Her.

Common in late summer.

ORDER HYPOCREALES.

Family *Hypocreaceae*.53. *HYPOMYCES LACTIFLUORUM* (Schwein.) Tul.

On some species of *Agaricaceae*, probably *Lactaria*.

One collection of some half dozen infected plants was made in late summer.

54. *HYPOMYCES POLYPORINUS* Peck.

On *Coriolus versicolor* (L.) Quel. (*Polystictus* Fries.)

Found once in some abundance in the early spring, probably of the previous year's growth. According to Seaver* this species is known only from New

*Mycologia 2:78. 1910.

Jersey, New York, North Dakota, and some Canadian station. Probably of wide distribution.

55. *CLAVICEPS PURPUREA* (Fries) Tul.

On *Agropyron repens* (L.) Beauv. V.

Sclerotia were found rather abundantly, but were not germinated so the reference is only provisional.

ORDER DOTHIDIALES.

Family Dothideaceae.

56. *PHYLLACHORA GRAMINIS* (Pers.) Fuckel.

On *Hystrix patula* Moench (H. *Hystrix* Millsp.) *Bouteloua curtispēdula* (Michx.) Torr., (*Atheropogon curtispēdulus* Fourn.), and *Sorghastrum nutans* (L.) Nash (*S. avenaceum* Nash).

Very common.

57. *PHYLLACHORA JUNCII* Fuckel.

On *Juncus interior* Wiegand.

Rather abundant in late summer.

58. *PHYLLACHORA LESPEDIZAE* (Schw.) Sacc.

On *Lespedeza capitata* Michx.

Not uncommon.

59. *FLOWRIGHTIA MORBOSA* (Schwein.) Sacc.

On *Prunus americana* Marsh. and *P. virginiana* L.

So far as personal observation goes this species which causes the "Black knot" of drupaceous fruits is confined to the wild members of the genus *Prunus*. Upon the choke cherry this disease is very abundant and if infection is possible from this host then the abundance of choke cherries in this region is a serious menace to our orchards.

ORDER SPHAERIALES.

Family Sphaeriaceae.

60. *VENTURIA POMI* (Fries) Winter. [*Fusicladium dendriticum* (Wallr.) Fuckel.]

On *Pyrus iowensis* (Wood) Bailey (*Malus Britton*).

The common apple scab is the conidial stage of this species. Not seen on the cultivated apple, but abundant on the wild crab.

Family Mycosphaerellaceae.

61. *GUIGNARDIA BIDWELLII* (Ellis) Vala & Ravaz. [*Laestadia Bidwellii* (Ellis) Sacc., *Phyllosticta viticola* Thum., *P. ampelopsidis* Ellis & Martin].

On *Psedera quinquefolia* (L.) Greene (*Parthenocissus* Planch.), *P. quinquefolia hirsuta* (Donn) Rehder, and *vitis vulpina* L.

The black rot of the grape. Abundant on leaves and fruits of the wild grape and on the leaves of the Virginia creeper, being a most destructive pest to both.

62. MYCOSPHAERELLA FRAGARIAE (Tul.) Lindau. [*Sphaeriella Fragariae* (Tul.) Sacc., *Ramularia Fragariae* Peck.].

On *Fragaria virginica* Duchesne, and *F. americana* Britton.

The strawberry rust. Very abundant on the first host named but rare on the last one. Only the conidia were seen.

ORDER PHACIDIALES.

Family Phacidianaceae.

63. RHYTISMA ACERINUM (Pers.) Fries.

On *Acer saccharinum* L.

The "tar spot" disease of maples was rather abundant throughout the county during the past season.

64. RHYTISMA SALICINUM (Pers.) Fries.

On *Salix lucida* Muhl.

Found once in fair abundance.

65. RHYTISMA SOLIDAGINIS Schwein.

On *Aster cordifolius* L., *Solidago graminifolia* (L.) Salisb. (*Euthamia* Millsp.) and *S. latifolia* L. (*S. flexicaulis* L.).

The exact nature of this species is in doubt, for while it is known that an insect gall always forms a part of the spot there are always fungous hyphae present, but so far no spores have been observed.

ORDER PEZIZALES.

Family Helotiaceae.

66. SCLEROTINIA FRUCTIGENA (Pers.) Schroeter. [*Monilia fructigena* pers.]

On fruits of *Prunus americana* Marsh.

The common brown rot of stone fruits, which is very destructive to certain races of both wild and cultivated plums and cherries.

67. SCLEROTINIA TUBEROSA (Hedw.) Fuckel.

On *Anemone quinquefolia* L.

A single small clump of this species has been collected. The subterranean sclerotia are attached to the rhizomes of the wood anemone. In some localities the fungus is abundant enough to be quite destructive.

Family Mollisiaceae.

68. MOLLISIA DEHNII (Rabenh.) Karst.

On *Potentilla monsepalensis* L.

Abundant on stems, leaves, and leaf veins of the host in early summer.

CLASS DEUTEROMYCETES.

ORDER PHOMATALES.

Family Phomataceae.

69. PHYLLOSTICTA APOCYNI Trel.

On *Apocynum androsaemifolium* L.

Not common, midsummer.

70. PHYLLOSTICTA COROLI West.

On *Corylus americana* L.

A fairly common but not over abundant leaf spot. Probably the present species, as is the case in certain other members of the genus, is associated with a leaf miner or some other insect.

71. PHYLLOSTICTA DECIDUA Ellis & Kellerm.

On *Lycopus rubellus* Moench., and *Mentha canadensis* L.

Quite common and often resembling, at least to the casual observer, the work of insects.

72. PHYLLOSTICTA DISCINCTA J. J. Davis.

On *Uvularia grandiflora* J. E. Smith.

Only a few leaves were found infected with this recently described species.

73. PHYLLOSTICTA FATICENS Peck.

On *Nymphaea advena* Ait.

Not uncommon, but in no wise an abundant species. Midsummer.

74. PHYLLOSTICTA GENTIANICOLA (DC.) Ellis & Everh.

On *Gentiana Andrewsii* Griseb.

A conspicuous, but rather uncommon species which appears in early summer.

75. PHYLLOSTICTA GROSSULARIAE Sacc.

On *Ribes gracile* Michx.

Very common and abundant in midsummer and autumn. Some bushes were completely defoliated by the middle of August.

76. PHYLLOSTICTA MELALEUCA Ellis & Everh.

On *Ulmus americana* L.

Not rare on sprouts of elm, appearing first in midsummer.

77. PHYLLOSTICTA RUBBECKIAE Ellis & Everh.

On *Rudbeckia laciniata* L.

Common and abundant on the wild plants by the first of August and continuing till frost. The variety under cultivation appears to be free from the fungus.

78. PHYLLOSTICTA VIOLAE Desm.

On *Viola* sp.

Common on the blue violet of the region.

79. AMPELOMYCES QUISQUALIS Cesati.

On *Erysiphe cichoracearum* DC. on *Aster* sp., *Verbena stricta* Vent., and *V. urticifolia* L.

On *Podosphaera Oxyanthae* (DC.) de Bary on *Prunus americana* Marsh.

Very common on the mycelium of various species of *Erysiphaceae* but not collected except as above. Probably every species of the family could be added to the list of hosts for this interesting species.

80. *Ascochyta Oxybaphi* Trel.

On *oxybaphus nyctagineus* (Michx.) Sweet (*Allonia nyctaginea*) Michx.

Rather common but neither abundant nor conspicuous.

81. ASCOCHYTA VIOLAE Sacc. & Speg.

On *Viola pubescens* Ait.

Not uncommon in midsummer.

82. DULARCIA FILUM (Riv.) Cast.

On *Puccinia Asparagi* (DC.), on *Asparagus officinalis* L., *Metampsora Bigelovii* Thum., on *Salix fluviatilis* Nutt., *M. Medusae* Thum., on *Populus deltoides* Marsh., *Uromyces Silphii* (Burr.) Arth. on *Juncus interior* Weigand.

Common and abundant on the uredinia and to a less extent on the tella of various species of rusts.

83. SEPTORIA AGRIMONIA Roum.

On *Agrimonia mollis* (T. & G.) Britton.

Rather common on stunted plants in July and August.

84. SEPTORIA CRYPTOTAENIAE Ellis & Ever.

On *Asclepias incarnata* L., and *A. syriaca* L.

Rather plentiful and quite conspicuous during the later summer and early autumn.

85. SEPTORIA ATROPURPUREA Peck.

On *Aster cordifolius* L.

The reddish brown discoloration render this a very conspicuous species, although it was not very abundant during the past season.

86. SEPTORIA CAMPANULAE (Lev.) Ellis.

On *Campanula americana* L.

Common and abundant during late summer. The peculiar seared appearance of the leaves renders this a rather conspicuous species.

87. SEPTORIA CANNABINA West.

On *Cannabis sativa* L.

Abundant on hemp from late July to frost, producing spores freely although sometimes said to fruit sparingly.

88. SEPTORIA CONSPICUA Ellis & Mart.

On *Steironema ciliatum* (L.) Raf.

Rather scarce, appearing in early summer.

89. SEPTORIA CORNICOLA Desm.

On *Cornus alternifolia* L. f.

Found very sparingly during the last of July.

90. SEPTORIA CRYPTOTAENIAE Ellis & Rav.

On *Cryptotaenia canadensis* (L.) DC. (*Doeringia* Kuntze).

Common throughout the early summer, sometimes almost covering the entire leaf.

91. SEPTORIA CACCALIAE Desm.

On *Caccalia reniformis* Muhl. (*Masadenia* Raf.)

Fairly common during the flowering season of the host.

92. SEPTORIA DIERVILLAE Ellis & Everh.

On *Diervilla Lonicera* Mill. (*D. Diervilla* MacM.)

Not abundant, seen only on July 30, 1909.

93. SEPTORIA ERIGERONTIS Peck.

On *Erigeron annuus* (L.) Pers., and *E. ramosus* (Walt.) BSP.

Common and abundant on both hosts, especially the former.

94. SEPTORIA LACTUCIOLA Ellis & Everh.

On *Lactuca canadensis* L., and *L. hirsuta* Muhl.

Common but not abundant during midsummer.

95. SEPTORIA LEPTOSTACHYA Ellis & Everh.

On *Phryma Leptostachya* L.

Common during the summer and rather conspicuous.

96. SEPTORIA MALVICOLA Ellis & Mart.

On *Malva rotundifolia* L.

Rather common and plentiful during the summer months.

97. SEPTORIA OCLATA Ellis & Kell.

On *Vernonia altissima* Nutt. (*V. maxim* Small).

Rather abundant during late summer.

98. SEPTORIA OENOTHERAE B. & C.

On *Oenothera biennis* L. (*Onagra* Seop.).

One of the commonest and most abundant species of the genus, hardly a plant of the host escaping the ravages of the fungus.

99. SEPTORIA PARIETARIAE J. J. Davis.

On *Parietaria pennsylvanica* L.

Common and rather abundant in some patches of the host and less plentiful in others. The infection resembles that of *S. Campanulae* quite closely.

100. SEPTORIA PODOPHYLLINA Peck.

On *Podophyllum peltatum* L.

Common on the languishing leaves of the host, and easily overlooked on account of the lack of definite spots and the resemblance of the infection to dying leaves.

101. SEPTORIA PRENANTHIS Ellis & Everh.

On *Prenanthes alba* L. (*Nabalus albus* Hook.)

Not abundant.

102. SEPTORIA RUBI Westend.

On *Rubus occidentalis* L.

Of exceptional occurrence during the past season but probably abundant both on wild and cultivated berries. This is frequently a very destructive pest.

103. SEPTORIA SCROPHULARIAE Peck.

On *Scrophularia marylandica* L.

Common and abundant throughout the summer.

104. SEPTORIA SCUTELLARIAE Thuem.

On *Scutellaria lateriflora* L.

Only seen once during the past season, apparently not an abundant species.

105. SEPTORIA SILENES Westd.

On *Silene stellata* (L.) Ait.f.

A single station noted, but here the infection was abundant, scarcely a full grown leaf remaining healthy.

106. SEPTORIA SMILICANAE Ellis & Mart.

On *Smilicana racemosa* (L.) Desf. (*Vagnera Morong*.)

Of rather common occurrence and usually abundant in infected clumps.

107. SEPTORIA TOXICODENDRI Curtis.

On *Rhus Toxicodendron* L. (*R. radicans* L.)

Probably common and abundant.

108. SEPTORIA UETICAE Desm.

On *Laportea canadensis* (L.) Gaud. (*Urticatum divaricatum* (L.) Kuntze.)

Not common nor abundant.

Family *Leptostromataceae*.

109. LEPTOTHYRIUM POMI (Mont. & Fr.) Sacc.

On *Pyrus Malus* L. (*Malus Malus* Britton).

The fly speck disease of apples. Not uncommon, but not destructive as it is confined to the cortical cells of the fruit which it disfigures more than it injures.

110. MELASMIA GALII Ellis & Everh.

On *Galium boreale* L.

Not common.

ORDER MELANCONIALES

Family *Melanconiaceae*.

111. CYLINDROSPORIUM HUMULI Ellis & Everh.

On *Humulis Lupulus* L.

Not common, but the infested vines are usually well infected.

112. MARSONIA JUGLANDIS Sacc.

On *Juglans cinerea* L.

Common and abundant on the butternut which is sometimes almost defoliated by the fungus.

113. GLEOSPORIUM CONFLUENTIS Ellis & Dearn.

On *Sagittaria latifolia* Willd.

Common and conspicuous, frequently almost destroying the leaves.

114. GLEOSPORIUM DAVISII Ellis & Everh.

On *Lathyrus venosus* Muhl.

A single cluster of pods were found infected in early August.

ORDER MONILIALES.

Family Moniliaceae.

115. ALTERNARIA BRASSICAE (Berk.) Sacc.

On *Brassica nigra* (L.) Koch.

Not common, but rather conspicuous, probably to be found on other closely related hosts.

116. ALTERNARIA PANAX Whetzel.

On *Panax quinquefolia* L.

A very destructive pest in ginseng beds but so far not observed on the wild plants. It is only by the most persistent efforts that growers are able to produce a crop.

117. SEPTOCYLINDRIUM RUFOMACULANS (Peck) Pound & Clements. [*Ramularia rufomaculans* Peck.]On *Polygonum aviculare* L.

Common and abundant, often almost defoliating its host.

118. MONILIA ANGUSTIOR (Sacc.) Reade.

On *Prunus virginiana* L.

Common, but nowhere abundant on the immature fruits of the choke cherry. Probably the conidial phase of some species of *Sclerotinia*.

119. DIDYMARIA DIDYMA (Unger) Pound. [*Ramularia didyma* Unger, *D. Ungerii* Corda.]On *Ranunculus recurvatus* Poir, and *R. septentrionalis* Poir.

Common, but not very abundant. A conspicuous fungus owing to the frosted appearance of the conidiophores and the large epiphyllous discolorations.

120. RAMULARIA ARMORACIA Fuckel.

On *Radicula Armoracia* (L.) Robinson (Roripa A. S. Hitch.)

A very abundant species, practically every plant of horseradish being infected.

121. RAMULARIA ARVENSIS Sacc.

On *Potentilla monsepalsensis* L.

A common leafspot in the later weeks of summer and during the autumn.

122. RAMULARIA RUDBECKII Peck.

On *Rudbeckia laciniata* L.

Not uncommon in midsummer.

123. RAMULARIA TARAXICA Karst.

On *Taraxacum officinale* Weber (T. *Taraxacum* Karst.)

Common and abundant, especially in early summer.

124. CERCOSPORA ALISMATIS Ellis & Holw.

On *Alisma Plantago-aquatica* L.

Neither common nor abundant. Appearing in early summer.

125. CERCOSPORA AMPELOPSIDIS Peck.

On *Psedera quinquefolia* (L.) Greene (*Parthenocissus* Planch) and *P. quinquefolia hirsuta* (Donn) Rehder.

Common and abundant, causing defoliation in some cases. This is a more destructive fungus than *Guignardia Bidwellii* as it covers more of the leaf surface.

126. CERCOSPORA ANTIPUS Ellis & Holw.

On *Lonicera Sullivanii* A. Gray.

Common, the infected vines usually with but few healthy leaves, but the spots are small and few on a leaf. Appearing in midsummer.

127. CERCOSPORA CANA Sacc.

On *Erigeron annuus* (L.) Pers., and *E. canadensis* L. (Leptilion Brotton.)

Common and abundant, especially on the first host. This species was later made the type of the genus *Cercosporella* Sacc., which is distinguished from *Cercospora* by its hyaline conidiophores and conidia, a distinction which cannot be accepted as valid.

128. CERCOSPORA CAULOPHYLLI Peck.

On *Caulophyllum thalictroides* (L.) Michx.

Rather common, but not abundant. The fungus appears about the time the berries are full grown.

129. CERCOSPORA CHIENOPODII Fries.

On *Chenopodium album* L., and *C. album virde* (L.) Moq.

Common and abundant in summer and autumn.

130. CERCOSPORA CLAVATA Gerard.

On *Asclepias syriaca* L.

Not uncommon during midsummer.

131. CERCOSPORA DAVISII Ellis & Everh.

On *Melilotus alba* Desv.

Found abundantly in one locality in July.

132. CERCOSPORA DIOSCOREAE Ellis & Martin.

On *Dioscorea villosa* L.

Not common, and when present infecting but a few leaves.

133. CERCOSPORA ECHINOCYSTIDIS Ellis & Martin.

On *Echinocystis lobata* (Michx.) T. & G. (*Micrampelis* Greene.)

A single vine was found scantily infected.

134. CERCOSPORA GERANII Kell. & Swing.

On *Geranium maculatum* L.

Found sparingly in midsummer.

135. CERCOSPORA GRANULIFORMIS Ellis & Holw.

On *Viola* sp.

Not uncommon in midsummer.

136. CERCOSPORA HEUCHERI Ellis & Mart.

On *Heuchera hispida* Pursh.

Infrequent, but with an abundant infection where found. Collected in July.

137. CERCOSPORA MENISPERMI Ellis & Holw.

On *Menispermium canadensis* L.

Common and abundant during the entire summer.

138. CERCOSPORA OXYBAPHI Ellis & Holw.

On *Oxybaphus nyctagineus* (Michx.) Sweet (*Allonia* Michx.)

Not common nor abundant. Collected during midsummer.

139. CERCOSPORA POLYGONORUM Cooke.

On *Polygonum Hydropiper* L.

Not uncommon and where present quite abundant. The blackish hypophyllous growth makes this a very conspicuous species.

140. CERCOSPORA RACEMOSA Ellis & Mart.

On *Teucrium canadense* L.

Not very common but fairly abundant in infected patches of the host. Autumn.

141. CERCOSPORA ROSÆCOLA Pass.

On *Rosa pratincola* Greene.

Not common, appearing in midsummer.

142. CERCOSPORA SII Ellis & Everh.

On *Sium cicutaefolium* Gmel.

Not common, but where present rather abundant. Midsummer.

143. CERCOSPORA TOXICODENDRI Ellis.

On *Rhus Toxicodendri* L. (*R. radicans* L.)

Not uncommon and in some places at least, quite abundant. The infected areas suggest the work of some insect as the discoloration is about the same as that produced by the drying sap of the host. On the under surface the conidia give the spots a frosted appearance. The species is of more than ordinary interest as the note appended to the description in Ellis and Everhart's Enumeration of the North American Cercosporae is "On leaves of *Rhus Toxicodendron*,

Newfield, N. J. Not since found, and hence doubtful."* The material agrees thoroughly with the description and so removes this from the list of doubtful species.

144. *CERCOSPORA VARIA* Peck.

On *Viburnum Lentago* L.

Not common or abundant. Midsummer.

145. *CERCOSPORA ZEBRINA* Pass.

On *Trifolium pratense* L.

Rather a common disease of the red clover, but probably not causing much loss to the crop.

146. *SCOLECOTRICHUM GRAMINIS* Fuckel.

On *Muhlenbergia Mexicana* (L.) Trin.

Common, late summer and autumn.

147. *POLYTHRINCUM TRIFOLII* Kunze.

On *Trifolium pratense* L., and *T. repens* L.

Abundant on both white and red clover during the entire summer. This is said to be the conidial stage of an Ascomycete but is retained here as the perfect form was not collected and the following quotation indicates that the species is really not well known. "On account of the characteristics and habits of the mycelium and of the stroma sometimes produced, it has been assumed that the perfect stage would be a species of *Phyllachora*, and the plant actually bears also the name *Phyllachora Trifolii* (Pers.) Fekl."†

148. *CLADOSPORIUM TRIOSETI* Peck.

On *Trisetum perfoliatum* L.

Not rare in midsummer.

149. *HELMINTHOSPORIUM GRAMINEUM* Rabenh.

On *Hordeum vulgare* L.

Very abundant during the past summer causing a considerable shortage in the crop.

150. *MACROSPORIUM SOLANI* Ellis & Everh.

On *Datura Tatula* L.

Common and abundant throughout the summer.

Family *Tuberculariaceae*.

151. *TUBERCULINA PERSICINA* Ditm.

On the aecia of Uredinales: *Puccinia Caricis-asteris* Arth., on *Solidago latifolia* L. (*S. flexicaulis* L.), *Puccinia fraxinata* (Schw.) Arth., on *Fraxinus americana* L., *Puccinia Opizii* Bubak, on *Lactuca canadensis* L., *Puccinia Peckii* (De T.) Kellerm., on *Oenothera Biennis* L. (*Onagra Scop.*), *Puccinia Phrymae* (Halst.) Arth., on *Phryma Leptostachya* L.

*Jour. Myc. 1:62. 1885.

†Duggar, Fungous Diseases of Plants 298. 1910.

Not uncommon on various aecia, appearing as large or small purplish tubercles.

152. *FUSARIUM PARASITICUM* Ellis & Kell.

On *Puccinia Menthae* Pers., on *Monardo fistuloso* L.

Rather abundant, especially just previous to the appearance of the tella.

153. *FUSARIUM UREDINEUM* Ellis & Everh.

On *Melampsora Bigelowii* Thum., on *Salix lucida* Muhl., and *M. Medusae* Thum., on *Populus deltoides* Marsh.

Rather common on the uredinia of these two species, giving the sori the appearance of being covered with a white mould.

CLASS BASIDIOMYCETES.

ORDER USTILAGINLES

Family Ustilaginaceae.

154. *USTILAGO HORDEI* (Pers.) Kell. & Swing. [*U. segetum* p. p.]

On *Hordeum vulgare* L.

Abundant and destructive.

155. *USTILAGO NEGLECTA* Niessl. [*U. Panici-glauci* Wint.]

On *Setaria glauca* (L.) Beauv. (*Chaetochloa* Scribn.)

Rather abundant.

156. *USTILAGO RABENHORSTIANA* Kuehn.

On *Digitaria sanguinalis* (L.) Scop. (*Syntherisma* Dulac.)

Abundant in autumn.

157. *USTILAGO UTRICULOSA* (Nees) Tul.

On *Polygonum lapathifolium* L., and *P. pennsylvanicum* L.

Rather common in late summer and autumn.

158. *MELANOPSICHUM AUSTRO-AMERICANUM* (Speg.) G. Beck. (*Ustilago* Speg.)

On *Polygonum lapathifolium* L.

Rare, only three or four small sori being found in early autumn.

159. *SCHIZONELLA MELANOGRAMMA* (DC.) Schroeter.

On *Carex pennsylvanica* L.

Abundant in spring and early summer.

160. *SOROSPORIUM CENCHRI* P. Henn. [*Ustilago Syntherismae* Peck., not Schwein., *S. Syntherismae* Farlow.]

On *Cenchrus tribuloides* L.

Abundant in autumn. The specific name *Syntherismae* is based on a misinterpretation of specific limits which is analogous to a misdetermination in so far as the nomenclatural status of the combination is concerned. It has accordingly been thought preferable to use the name here employed.

Family Tilletiaceae.

161. UROCYSTIS ANEMONES (Pers.) Winter.

On *Anemone quinquefolia* L., and *Hepatica acutiloba* DC. (*H. acuta* Britton.)
Abundant in early spring. On *Anemone* frequently associated with other fungi.

162. ENTYLOMA AUSTRALE Speg. [*E. Physalidis* (Klachb. & Cooke) Winter, *E. Besseyi* Farl.]

On *Physalis pruinosa* L.

Abundant throughout the summer, partially defoliating the host.

163. ENTYLOMA COMPOSITARUM Farl.

On *Ambrosia artemisiaefolia* L., *A. trifida* L., *A. trifida integrifolia* (Muhl.)
T. & G. *Bidens frondosa* L., and *Lepachys pinnata* (Vent.) T. & G. (*Ratbida*
Barnh.)

Common and abundant throughout the summer.

164. ENTYLOMA MENISPERMI Farl & Trel.

On *Menispermium canadense* L.

Rare, in late autumn.

165. ENTYLOMA NYMPHAEAE (D. D. Cunn.) Setch.

On *Castalia tuberosa* (Paine) Greene.

Not common. Collected in late July.

166. ENTYLOMA POLYSPORUM (Peck.) Farl.

On *Ambrosia trifida* L.

Not common, throughout the summer.

167. ENTYLOMA SANICULAE Peck.

On *Sanicula* sp.

Not common on the root leaves in early spring.

168. DOASSANZIA DEFORMANS Setch.

On *Sagittaria latifolia* Willd.

Common and rather abundant on scapes, petioles, and leaves producing very prominent hypertrophy of the host. Late summer and autumn.

ORDER UREDINIALES

Family Coleosporiaceae.

169. COLEOSPORIUM SOLIDAGINIS (Schw.) Thuem.

On *Aster cordifolius* L., *A. puniceus* L., *A. sp. indet.*, *Solidago canadensis* L.,
S. latifolia L. (*S. flexicaulis* L.), and *S. serotina* Ait.

One of the most abundant of our rusts, and one with an exceptional range of hosts. Midsummer and autumn.

Family Melampsoraceae.

170. MELAMPSORA BIGELOWII Thuem [*M. farenosa* (Pers.) Schroet.]

On *Salix amygdaloides* Anders., *S. humilis* Marsh., *S. interior* Rowlee, *S. longifolia* Muhl. (*S. fluviatilis* auth., not Nutt.), and *S. lucida* Muhl.

Common during summer and autumn on willows.

171. MELAMPSORA LINI (Schum.) Desmaz.

On *Linum sulcatum* Riddell.

A single collection in the later part of June. Scarce.

172. MELAMPSORA MEDUSAE Thum [*M. populina* Jacq.]

On *Populus deltoides* Marsh.

Abundant on the Carolina poplar throughout the summer and autumn, but not noted on any other species of *Populus*.

173. PUCCINIASTRUM AGRIMONIAE (Schw.) Tranz. (*Uredo Agrimoniae* DC.)

On *Agrimonia gryposepala* Wallr. (*A. hirsuta* Bicknell), and *A. mollis* (T. & G.) Britton.

Not a common rust. Late summer and autumn.

174. PUCCINIASTRUM PYROLAE (Pers.) Dietel.

On *Pyrola elliptica* Nutt.

The uredinia collected sparingly late in May.

175. HYALOPSORA POLYPODII (DC) Magnus [*Uredo Polypodii* DC.]

On *Cystopteris fragilis* (L.) Bernh. (Filix Underw.)

Rather abundant in a single locality in the middle of July.

176. MELAMPSOROPSIS PYROLAE (DC.) Arth[*Chrysomyxa pirolatum* (Schw.) Wint.]

On *Pyrola elliptica* Nutt.

Rather abundant in May.

177. CRONARTIUM COMANDRAE Peck.

On *Comandra pallida* A. DC.

A small clump of the host found infected in early October.

Family Pucciniaceae.

178. PILEOLARIA TOXICODENDRI (Berk. & Rav.) Arthur. [*Uromyces Toxicodendri* Berk & Rav.]

II, III on *Rhus Toxicodendron* L. (*R. radicans* L.)

Not an uncommon rust, but the inconspicuous telia render it easily overlooked.

179. TRANZSCHELIA PUNCTATA (Pers.) Arth. [*Aecidium punctatum* Pers., *A. hepaticum* Schw., *A. Ranunculacearum* DC. *Puccinia prunosum* Link, *P. pruni-spinosae* Pers.]

I on *Anemone quinquefolia* L., and *Hepatica acutiloba* DC. (*H. acuta* Britton.)

II, III on *Prunus americana* Marsh.

The aecial stage is one of the commonest and most abundant of our rusts. The later stages are usually abundant where found, but not so common as the aecia. The mycelium appears to be perennial in *Anemone* and *Hepatica* so this stage can appear without indicating the probable abundance of the rust on the alternate hosts.

180. POLYTHELIS FUSCA (Pers.) Arth. [*Puccinia fuscum* (Pers.) Winter.]
On *Anemone quinquefolia* L.

This is one of the most abundant of our early rusts, the sori appearing sometimes before the leaves are full grown. Only O and III.

181. UROPYXIS AMORPHAE (M. A. Curt.) Schroter. [*Puccinia Amorphae* f. A. Curtiss.]

III on *Amorpha fruticosa* L.

Common in late autumn, and usually abundant where found.

182. PHRAGMIDIUM ROSAE-ARKANSANAE Dietel.

I, II, III on *Rosa pratincola* Greene.

Rather uncommon and not abundant.

183. GYMNOCONIA INTERSTITIALIS (Schl.) Lagerh. [*Uredo caeoma-nitens* Schw., *Caeoma nitens* Schw.]

On *Rubus* sp. indet.

Common on the wild blackberry.

184. KUEHNEOLA POTENTILLAE (Schw.) Arthur. [*Phragmidium obtusum* (Straus) Winter.]

II, III on *Potentilla canadensis* L.

Rather common. The primary uredo of this species is the first rust to appear in the spring.

185. GYMNOSPORANGIUM CORNICULANS Kern.

On *Amelanchier canadensis* (L.) Medic.

Pycnia and immature aecia were collected just as the leaves were falling from a tree badly infested with *Dimerosporium Colisonii*. "The telia of this species are to be found on the branches of the red cedar and produce galls which are woody and irregularly globular, ranging from a few millimeters to two or three centimeters in diameter. They are readily told from the galls of *Gym. Juniperi-virginianae*, but are not unlike those of *Gym. nidus-avis*. . . . Only one collection of the telia has yet been made. . . . (This) was obtained in northern Michigan." Arthur in Litt.

186. GYMNOSPORANGIUM GLOBOSUM Farlow. [*Roestelia lacerata* Fries.]

I on *Crataegus punctata* Jacq., and *C. rotundifolia* Moench.

III on *Juniperus virginiana* L.

Common and abundant both on the cedar and the thorn. Of the last scarcely a healthy leaf remains on many trees.

187. GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE Schw. [*G. macropus* Link, *Roestelia pyrata* Thax.]

I on *Pyrus ioensis* (Wood) Bailey (*Malus Britton*), and *P. Malus* L. (*M. Malus Britton*.)

III on *Juniperus virginiana* L.

Very common and abundant. The cedar apples are more conspicuous than in the preceding species, but locally no more abundant. The wild crab is most

seriously affected, leaf, twigs, and fruit bearing the rust while the infection on the cultivated apple is only nominal.

188. *GYMNOSPORANGIUM NIDUS-AVIS* Thaxter.

III on *Juniperus virginiana* L.

Not uncommon on cedar trees on the windward side of high bluffs, but so far not taken on the leeward side of hills or on level land where the wind is broken at a short distance.

189. *UROMYCES ACUMINATUS* Arth.

II, III on *Spartina cynosuroides* Willd.

Not uncommon. Probably the aecia of this species appears on *Polemonium*.

190. *UROMYCES ALBUS* D. & H.

I on *Vicia americana* Muhl.

The aecia were rather abundant but telia were not observed. This is the only species of *Uromyces* we have which omits the uredinia.

191. *UROMYCES CALADII* (Schw.) Farl. [*Aecidium Caladii* Schw.]

I, II, III on *Arisaema triphyllum* (L.) Schott.

I on *Arisaema dracontium* (L.) Schott.

One of our most abundant and most conspicuous rusts.

192. *UROMYCES EUPHORBIAE* Cooke & Peck. [*Aecidium Euphorbiae* Schw.]

I, II, III on *Euphorbia humistrata* Engelm.

Common and abundant. The erect habit of the plant infected with the aecia renders it a comparatively conspicuous species.

193. *UROMYCES FABIAE* (Pers.) de Bary. [*Aecidium porosum* Peck.]

III on *Lathyrus venosus* Muhl., and *Vicia americana* Muhl.

Not common nor abundant.

194. *UROMYCES HOWEI* Peck.

II, III on *Asclepias syriaca* L.

Rather common and where found quite abundant.

195. *UROMYCES LESPEDEZAE-PROCUMBENTIS* (Schw.) Curt. [*U. Lespedezae* (Schw.) Peck.]

III on *Lespedeza capitata* Michx.

Not very common nor overly abundant.

196. *UROMYCES PYRIFORMIS* Cooke.

III on *Acorus calamus* L.

Rather abundant on the only clump of the host visited. October.

197. *UROMYCES RUDBECKIAE* Arth. & Holw.

III on *Rudbeckia laciniata* L.

Common and abundant on the wild form of the host but not seen on the cultivated variety. The only *Uromyces* in our territory which produces telia without either aecia or uredinia.

198. UROMYCES SILPHII (Syd.) Arth. [*U. Junci* Tul.]

I on *Silphium laciniatum* L. (Herb. Arthur.)

II, III on *Juncus Interior* Wiegand.

A single sorus of the æcial stage was found while the other stages are very common.

199. UROMYCES TRIFOLII (Hedw. f.) Lev.

I, II, III on *Trifolium repens* L.

Rather abundant on the white clover, but not found on the red.

200. PUCCINIA ALBIPERIDIA Arth.

I on *Ribes Cynosbati* L., *R. florida* L'Her., and *R. gracile* Michx.

Very abundant on both species of gooseberries, but scarce on the currant. It is possible that two species are included here but as the corresponding forms on *Carex* have not been collected it is rather difficult to say.

201. PUCCINIA ANEMONES-VIRGINIANAE Schw.

On *Anemone virginiana*.

Common from early spring to late autumn. Aecia and telia both lacking.

202. PUCCINIA ANGUSTATA Peck.

III on *Scirpus atrovirens* L.

Found sparingly in late autumn. The aecia, which are on *Lycopus* have not been collected here.

203. PUCCINIA ASPARAGI DC.

II, III on *Asparagus officinalis* L.

Common, especially on wild asparagus, sometimes becoming a pest in gardens.

204. PUCCINIA ASTERIS Duby.

On *Aster cordifolius* L. and *A. paniculatus* Lam.

Common and often very abundant. Aecia and uredinia absent.

205. PUCCINIA CARICIA-ASTERIS Arth. [AECIDIUM ASTERATUM Schw.]

I on *Aster cordifolius* L.

II, III on *Carex cephalophora* Muhl.

Rather rare, both æcia and the other forms appearing in midsummer.

206. PUCCINIA CARICIS-ERIGERONTIS Arth. [Aecidium erigeronatum Schw.]

I on *Erigeron annuus* (L.), Pers., *E. canadense* L. (Leptilon Britton), and *E. philadelphicus* L.

Abundant, but the telial stage has not yet been collected.

207. PUCCINIA CARICIS-SOLIDAGINIS Arth.

I on *Solidago latifolia* L. (*S. flexicaulis* L.), *S. serotina* Ait., and *S. ulmifolia* Muhl.

Common but not abundant.

208. PUCCINIA CIRCAEAE Pers.

On *Circaea lutetiana* L.

Common and rather abundant, Aecia and uredinia wanting.

209. PUCCINIA CLAYTONIATA, (Schw.) Arth.

I, III on *Claytonia virginica* L.

Common and abundant, the æcia appearing with the flowers and the telia with the ripening seeds. Uredinia wanting.

210. PUCCINIA CONVULVULI (Pers.) Cast.

I, II, III on *Convolvulus sepium* L.

The æcia appear in early summer, while the telia persist till frost. Common.

211. PUCCINIA EATONIAE Arth.

I on *Ranunculus abortivus* L.

Not common, but the infection usually abundant.

212. PUCCINIA ELEOCHARIDIS Arth [*Aecidium tenue* Schw.]

I on *Eupatorium purpureum* L.

Only a few sori found and these in a comparatively dry woods.

213. PUCCINIA EMACULATUM Schw.

II, III on *Panicum capillare* L.

Common and abundant.

214. PUCCINIA EPIPHYLLA (L.) Wettst.

II on *Poa pratensis* L.

Found in but one locality, but quite abundant there.

215. PUCCINIA FRAXINATA (Schw.) Arth. [*P. arundinariae* Schw., *Aecidium Fraxini* Schw.]

I on *Fraxinus americana* L.

III on *Spartina cynosuroides* (L.) Willd.

A single sorus of the æcial stage found and only a scant infection of telia.

216. PUCCINIA HELIANTHI Schw.

I on *Helianthus tracheliiifolius* Mill., and *H. strumosus* L.

II, III on *Helianthus annuus* L., *H. decapetalus* L., *H. doronicoides* Lam., and *H. grosseserratus* Martens.

Abundant throughout the summer.

217. PUCCINIA HYDROPHYLLI Cooke & Peck.

III on *Hydrophyllum virginicum* L.

Collected in but one station in early spring. Probably the other spore forms are wanting.

218. PUCCINIA IMPATIENTIS (Schw.) Arth. [*Aecidium Impatientatum* Schw.]

I on *Impatiens aurea* Willd.

III on *Elymus canadensis* L.

Neither collection of this species represented an abundant infection.

219. PUCCINIA KUHNIAE Schw.

II, III on *Kuhnia eupatorioides* L.

Not abundant. Aecia wanting.

220. PUCCINIA MAJANTHAE (Schw.) Arth. & Holw.

I on *Polygonatum biflorum* (Walt.) Ell. (Salomonina Britton.)

A single plant was found with æcia.

221. PUCCINIA MENTHAE Pers.

II, III on *Pycnanthemum pilosum* Nutt. (Koellia Britton), *Mentha cana-*
sis L., and *Monarda fistulosa* L.

Abundant and common.

222. PUCCINIA MUHLENBERGIAE Arth. & Holw.

II on *Muhlenbergia Schreberi* J. F. Gmel. (M. diffusa Willd.)

A single clump of the host was found abundantly infected, in midsummer.

223. PUCCINIA OPIZHII Bubak.

I on *Lactuca canadensis* L., and *L. pulchella*.

The æcia of this species is not abundant and the telia have been collected
America only once or twice. The alternate host is an undetermined species
Carex.

224. PUCCINIA PECKII (De T.) Kellerm. [*Aecidium Oenotherae* Peck.]

I on *Oenothera biennis* L. (Onagra Scop.)

III on *Carex longirostris*.

The æcia of this species are produced very abundantly in spring and early
amer.

225. PUCCINIA PHRYMAE (Hals.) Arth. [*Aecidium Phrymae* Hals.]

I on *Phryma leptostachya* L.

In one woods the æcia are produced abundantly from early spring to mid-
summer.

226. PUCCINIA PIMPINELLAE (Str.) Link.

On *Osmorhiza Claytoni* (Michx.) Clarke, and *O. longistylis* (Torr.) DC.
Washingtonia sps. Britton.)

Autecious. Common and abundant in spring and early summer.

227. PUCCINIA PLUMBERIA Peck.

I on *Phlox paniculata* L. (Herb. Arthur.)

A single sorus was collected. Dr. Arthur says that the form may be hete-
cious, but for the present refers it here. The only other collection of æcia
this host is recorded by Tracy who reports it from Starkville, Miss.*

228. PUCCINIA POCULIFORMIS (Jacq.) Wettst. [*P. graminis* Pers.]

II, III on *Agropyron repens* (L.) Beauv., *Agrostis alba* L., and *A. alba vul-*
is (With.) Thurb.

A common rust.

229. PUCCINIA PODOPHYLLI (Schw.) Link.

I, III on *Podophyllum peltatum* L.

*Bull. Miss. Agr. Exp. Sta., 34:90. 1895.

The conspicuous æcia of early spring are followed directly by the inconspicuous telia, the uredinia being elided. Not as common as the abundance of the host would indicate.

230. PUCCINIA POLYGONI-AMPHIBIAE Pers. [*Aecidium Geranii* DC.]

I on *Geranium maculatum* L.

II, III on *Polygonum amphibium* L.

The æcia are rather common, but never abundant, while the telia were collected but once, then in fair abundance.

231. PUCCINIA PUSTULATA (Curt.) Arth. [*A. pustulatum* Curt., *Puccinia Andropogi* Schw.]

I on *Comandra umbellata* (L.) Nutt., and *C. pallida* A. DC.

III on *Andropogon furcatus* L.

Rather a common species, and always abundant when found.

232. PUCCINIA PUNCTATA (Str.) Link.

II, III on *Galium tinctorium* L.

Rare, and never abundant.

233. PUCCINIA RHAMNI (Pers.) Arth. [*P. coronata* Corda.]

II, III on *Avena sativa* L.

This is the common rust of oats. It is quite abundant, especially on self sown oats.

234. PUCCINIA SILPHII Schw.

On *Silphium perfoliatum* L.

The telia appear in early spring and continue in fair abundance throughout the summer. The æcia and uredinia are omitted in this species.

235. PUCCINIA SORGHI Schw. [*P. Maydis* Carrau.]

On *Zea Mays* L.

Common, but apparently not detrimental, at least to any considerable extent.

236. PUCCINIA TARAXACI Plowr. [*P. flosculosorum* (A. & S.) Wint.]

II, III on *Taraxacum officinale* Willd. (*T. Taraxacum* Karst.)

Common and abundant throughout the summer. The æcia are elided.

237. PUCCINIA URTICAE (Schum.) Lagerh. [*Aecidium Urticae* Schum., *P. caracis* Aut. p.p.]

I on *Urtica gracilis* L.

Æcia collected sparingly, telia not seen.

238. PUCCINIA VIOLAE (Schum.) DC.

I on *Viola papilionacea* Nutt., *V. pubescens* Ait., and *V. scabriuscula* Schw.

The æcia are abundant in spring but later stages have not been observed.

239. AECIDIUM CAMPANULASTRI n. sp.

On *Campanulastrum americanum* (L.) Small (*Campanula americana* L.), Fayette, Iowa, June 25, 1909.

Aecia subepidermal, amphiginous, irregularly scattered over more or less rounded yellowish discolored areas which measure about 5 mm. across, short cylindric or deeply cuplike, 0.4-0.7 mm. across; peridium ample, of irregularly polyhedral cells about 15x20 micra, minutely granular; æciospores globose, often more or less angular, 12-18x10-15 micra; wall very light yellow, about 1.5 micra thick, smooth.*

Collected but once and then not in abundance. The discolored areas are of sufficient size and of deep enough a color to render the æcia quite conspicuous. No trace of pycnia were observed in the material examined. Probably has its alternate form on some grass or sedge.

240. *AECIDIUM COMPOSITARUM* Mart.

On *Polymnia canadensis* L., and *Rudbeckia laciniata* L.

A superficial comparison of the æcia on these two hosts is sufficient to convince one that they belong to two species of rusts. On *Polymnia* the infected area is rather large, bright yellow, and has the cups scattered irregularly and unevenly over the under surface. On *Rudbeckia* the discoloration is pale, tending to brownish in the center, the cups being grouped closely on the underside and pale yellow. The collection on *Polymnia* is interesting as the only previous record for this host is Racine, Wis. The material was found on the windward side of a hill, with no apparent source of infection at hand. The æcia on *Rudbeckia* were rather common and fairly abundant.

241. *AECIDIUM HYDROPHYLLI* Peck.

On *Nemophylla microcalyx* (Nutt.) Fisch & Mey. (*Macrocalyx Nyctelea* Kuntze.)

Rather abundant in one station, but no clue to its relationship was found.

242. *AECIDIUM HYDNOIDEUM* B. & C.

On *Dirca palustris* L.

A very conspicuous form, but not common or abundant.

243. *AECIDIUM POLEMONII* Peck.

On *Polemonium reptans* L.

Rather abundant in one station. Probably connected with *Uromyces acuminatus* Arth. on *Spartina*.

244. *AECIDIUM XANTHOXULI* Peck.

On *Xanthoxylon americanum* Mill.

An inconspicuous form which was found sparingly on wind swept hillsides in late July.

ORDER EXOBASIDIALES.

Family *Exobasidiaceae*.

245. *MICROSTROMA JUGLANDIS* Sacc.

On *Juglans cinerea* L.

Not uncommon, causing white areas on the under surface of the leaf.

**Aecia* subepidermalis, amphiginis, irregularis dispersis, brevis cylindraceis, vel cupuliformibus, 0.4-0.7 mm. crassis; peridiis amplis, cellulis irregularibus polygonis, granularibus; sporis globosis, vel angularis, 12-18 x 10-15 micra; membranis flavidis vel subhyalinibus, circa 1.5 micra crassis.

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THE STAMINATE FLOWER OF ELODEA.

BY ROBERT B. WYLIE.

Vegetatively *Elodea* is perhaps the best known of the submersed seed plants, as it is so commonly employed in the laboratory for experiment and study. The flowers, however, have received proportionately less study since they are small and inconspicuous and seldom appear in the usual laboratory aquaria. The purpose of this paper is to call attention to an unusual form of staminate flower recently noted.

While the flowers in this genus are usually functionally dioecious they are of special interest in that the suppressed parts are nearly always present in rudimentary form and the separation of the sporangia is doubtless correlated with their adjustment to the aquatic environment. They are unquestionably quite recently derived from perfect flowers. They present an ingenious solution of the problem of pollination since the minuteness of the flowers enables them to use the surface film of water to good advantage.¹

The pistillate flowers of *Elodea*, as is well known, are regularly elongated, and reach the surface, if at all, through the lengthening of that part of the flower between the ovary and floral parts. This "floral-tube" of the epigynous flower may attain to a length of 10-15 centimetres though having a diameter of only a fraction of a millimetre. The staminate flower, on the other hand, employs an entirely different method of reaching the surface of the water. These ordinarily do not elongate, or but slightly, and remain until fully developed within the sessile globose spathe. At maturity the stem or pedicel weakens, the flower escapes from the sheath, and rises to the surface of the water, there scattering the pollen. My observations have led me to think that the detachment and rapid rise of these flowers and their bursting open as well is greatly facilitated by the bubbles of gas that form at their tips buoying them up like balloons tugging at their anchorages.

During the summer of 1909, in connection with work at the Iowa Lakeside Laboratory, the writer noted an unusual form of staminate

¹Wylie, R. B. The Morphology of *Elodea Canadensis*. Bot. Gazette 37:1-22, 1904.

ower on the Elodea plants growing in the upper end of East Okoboji lake. These plants flourish most luxuriantly in the waters near the town of Spirit Lake, and every one of the hundreds of flowers examined displayed the same peculiarities, seeming to indicate a distinct strain of this genus in that locality.

The flowers under discussion displayed a form and habit markedly different from described types in that they elongated similarly to the pistillate flowers. The lower portion of the spathe early appears contracted giving it a stalked appearance, and this may be the condition described as "spathe peduncled" by Rydberg² in his description of *Elodea Planchonii* (Casp.) Rydb. and *E. linearis* Rydb, though the spathe is of course really sessile. The outer end of the spathe expands abruptly into a flattened, circular, cleft portion which loosely invests the body of the flower which is truly pedicellate on an axis within the spathe. At maturity the axis elongates pushing the flower out through the cleft in the spathe and upwards toward the surface of the water. The stamens and floral parts are thus carried up on a slender stalk looking very much like that of the pistillate flower. But while these habits are biological equivalents and the parts concerned look much alike the morphology of the structures involved is very different. The "floral tube" of the pistillate flower represents that complex of structures found above the ovary in epigynous flowers, while the elongated thread in the staminate flower is the pedicel.

The flower has usually a bubble of gas tugging at its apex, and in some instances it was noted that the attached flower had partly opened into this gas chamber. Sooner or later the weakened axis usually gives way and if the flower has not already reached the surface it rises and sheds its pollen on the surface film. The break occurs near the base, generally within the spathe, and the free floating flowers have each a long thread trailing behind. These become entangled and where the plants are numerous the empty flowers form windrows at the margins of the open water.

The degree of elongation in these staminate flowers is fully as great as in the pistillate flowers, and the lengthening of the axis is due to the stretching out of cells formed at an earlier stage. A measurement of these stalk cells at different stages showed that they increase in length early twenty-five times, this being accompanied by a slight decrease in breadth. These flowers show other structural differences which may not be taken up at this time.

²Rydberg, P. A. *Flora of North America*. 1909.

In brief, this form displays a type of flower and a mode of pollination apparently not hinted at in previously described species and offers the sharpest contrast to the habit of releasing the pollen bearing flowers without elongation. Biologically this trait is of interest as suggesting two unlike and probably independent types of evolution in this genus in the efforts of this plant to meet the difficulties of pollination in its habitat. The first and simpler, and doubtless the more primitive, is seen in the short-stalked flowers that come to nothing unless detached. The second and probably derived condition is seen in the attempt, often successful, to reach the surface by elongation of the axis, the plan regularly employed by the pistillate flower. The subsequent detachment of the staminate flowers may be due to the breaking down of tissues in the now useless structure.

The pistillate flower and the vegetative body conform more nearly to the described species, but in both departures were noted from the common type. In the opinion of the writer this form may deserve specific rank, and the name *Elodea Iowensis* (*Philotria Iowensis*) is proposed should it prove to be a new species. Further observations will be carried on this coming summer, and a more detailed description prepared in due time.

SPORE FORMATION IN LYCOGALA EXIGUUM MORG.

BY HENRY S. CONARD.

On the 5th of October, 1907, young aethalia of a *Lycogala* were collected in a grove four miles southwest of Grinnell, Iowa, killed in chromo-acetic acid and carried through into paraffin. Sections have shown some interesting stages in the development of spores. Since this process has hitherto been described in only two species of saprophytic myxomycetes, it seemed desirable to record the observation. Whether the organism in question is *Lycogala exiguum* or *L. epidendrum* cannot be certainly determined. Its small size and the fact that only four or five aethalia were found indicate the former species.

The specimens have already formed a peridium, in which are embedded the familiar masses of protoplasm with nuclei. The protoplasm of the main body of the aethalium is already divided into typical uni-nucleate spores. Tubular capillitial threads are frequent throughout the spore mass, but only rarely have they shown any connection with the peridium. In the outer portions of the aethalia, that is, adjacent to the peridium and on the free side of the body, there are in two cases many spherical and irregular masses of protoplasm containing from two to several nuclei. In one case these are apparently "pseudo-spores," or masses of substance whose development into spores was cut short—probably by desiccation. In the other, the process of spore formation was evidently arrested by the killing fluid. A third has an area of similar material through the middle of the fruit.

It is clear that the protoplasm is divided by irregular cleavages first into large, multinucleate blocks, and then into smaller and smaller portions, until finally but one nucleus remains to each piece. These pieces then round up and form spores. Meanwhile, nuclear division goes on, quite regardless of the lines of cleavage, until the final separation into spores.

The whole process, including the formation of pseudo-spores, is so precisely like that described by Harper in 1900 (*Bot. Gazette*) for *Fuligo*,

that it seemed not worth while to make figures. Harper's figures for *Fuligo* would exactly represent *Lycogala*. One difference exists. Whereas Harper found the spores perfected first at the periphery of the aethalium of *Fuligo*, the last cleavages of *Lycogala* may occur, either at the center or at the periphery.

EARLY HISTORICO-BOTANICAL RECORDS OF THE OENOTHERAS.

By R. R. GATES.

The present paper is an attempt to trace, as far as possible from available data, the history of the *Oenotheras*, particularly the large-flowered forms, in cultivation. An effort is also made to recognize, as far as this can be done, the precise characters of the various forms which have been figured or described during the last three centuries. Such records of course vary greatly in accuracy and value, for they are contemporaneous with the development of the science of botany itself. Judging from the number of polynomials applied to them by different authors, the *Oenotheras* would appear to have been as variable then as they are now. And I may say that my cultures of *Oenotheras* derived from various sources indicate that at present many of these forms are no less variable or mutable than the *O. Lamarckiana* of DeVries' experiments.

I have been able to examine a large number of references and plates of *Oenotheras*—many of them pre-Linnaean—from the valuable sets of Herbals and Icones in the library of the Missouri Botanical Garden. I wish to express my thanks to the Director, Professor William Trelease, for valuable aid in connection with the study of these early records. I am also indebted to Miss Cora J. Hogan, who has aided in deciphering the Snippendale manuscript and has also translated most of the Latin descriptions. I have attempted to trace, as far as possible, the history of *O. Lamarckiana* Ser., *O. grandiflora* Ait. and (in part) *O. biennis* L. from these early citations and plates. See also the important historical data supplied by Miss Vail in MacDougal (1903). The degree of accuracy of the plates varies greatly, but in many cases at least, one's conclusions concerning the plants figured can rest on a pretty certain basis, when they have a minute knowledge of the differentiating characters of these forms. *O. Lamarckiana* and *O. grandiflora* have often been confused with each other, and there was frequent failure to recognize these two as independent forms. The same is true of *O. biennis* and *O. Lamarckiana*. DeVries (1905) has

shown that the *O. Lamarckiana* now grown in European gardens, and from which the Hilversum cultures were derived, came from Texas, being imported by Messrs. Carter & Sons, London, about 1860. The forms closely resembling *O. Lamarckiana*, which were grown in European gardens and figured long previous to this, were from another source, and it is now established, from certain records in this paper, that that source must have been in Eastern North America, specifically "Virginia." The record of this last introduction of *O. Lamarckiana* into England is clear, but the earlier records have been very misty. It is certain, from results communicated here, that a form closely resembling though probably not identical with the *O. Lamarckiana* race of DeVries' cultures, was the first *Oenothera* taken to Europe from Virginia, about 1614.

In the case of *O. grandiflora*, the record of the introduction into Kew in 1778 is perfectly clear, as is also the account of the discovery of *O. grandiflora* in Alabama by Bartram about 1773. (See MacDougal *et al* 1905, p. 7). The plate of *O. grandiflora* by Barton, (1821), I regard as undoubtedly representing *O. grandiflora* rather than *O. Lamarckiana*, on account of the smooth stem, the slender rounded buds and delicate sepal tips, and the stem leaf (fig. 2), which is not broad at the base, like *O. Lamarckiana*, but correct for certain races of *O. grandiflora*. This plate is reproduced by a photograph in MacDougal (1905). Barton describes this plant as native in Carolina and Georgia. It is probable that *O. grandiflora* was formerly common in that region, and if an introduction of this plant into Europe took place at an earlier date than the one of which we have such a good historical record (as it almost certainly did), it must have been from seeds collected in the Eastern range of the species. It is probable that the Alabama and Carolina plants were not identical, belonging rather to closely related elementary species, but they must have been more closely related than *O. grandiflora* is to *O. Lamarckiana*. The differences between these races will be referred to later in this paper.

The volume which served as a starting point in following the early records of *Oenothera*, was Tournefort's *Institutiones** (1700) p. 302. Here the genus *Onagra* is characterized, accompanied by a plate (156) illustrating the *Onagra* flower, fruit and seed with considerable accuracy. At least one of the flowers illustrated is in the *O. biennis* series, with short style and small petals. One with somewhat longer style is apparently shown for contrast. Nine species of *Onagra* are then enumer-

*See MacDougal (1903), p. 754, for several other historical references.

ated as polynomials. Some of them have since been referred to other genera, such as *Jussiaea* and *Mentzelia*. They are as follows:

- (1) *Onagra latifolia*. *Lysimachia lutea*, *corniculata* C. B. Pin. 245.
- (2) *Onagra latifolia*, flore dilutiore. *Lysimachia corniculata non papposa*, *Virginiana*, *major*, flore sulphureo H. L. Bat.
- (3) *Onagra latifolia*, floribus amplis. *Lysimachia Virginiana*, *altera*, *foliis latioribus*, *floribus luteis*, *majoribus* Cat. Altdorf.
- (4) *Onagra angustifolia*, *Lysimachia angustifolia*, *Canadensis*, *corniculata*, H. R. Par. *Lysimachia Corniculata*, *lutea*, *Canadensis*, *minor*, seu *angustifolia* Mor. H. R. Bles.
- (5) *Onagra angustifolia*, caule rubro, flore minori.
- (6) *Onagra Americana*, folio *Betonicae*, fructu hispido Plum.
- (7) *Onagra Americana*, foliis *Persicariae* amplioribus, parvo flore luteo Plum.
- (8) *Onagra Americana*, foliis *Persicariae* angustioribus, magno flore luteo Plum.
- (9) *Onagra Americana*, frutescens, Nerii folio, magno flore luteo Plum.

The reference "Plum", in the last four, is to Plumier's "Description des Plantes de l'Amerique," published at Paris in 1693. An examination of this work showed that neither this nor the later edition (1713) contained descriptions or figures of any *Onagras*, but Plumier's Catalogue (1703) lists these forms. The explanation doubtless is that these four polynomials had been furnished to Tournefort by Plumier, but the latter had failed to complete his plates for publication in either edition of the work referred to. Later, in Plumier's *Plantarum Americanarum* the figures are published in the 7th fascicle, 1758. There (6) is referred to *Mentzelia* while (7) is described as *Jussiaea*; (8) and (9) are described with polynomials as *Oenothera*, with a reference to Browne's *History of Jamaica* (1756). The latter merely gives the polynomials of three "*Oenothera*" species, but Jacquin lists them in *Select. Stirp. Amer. Hist.* (1788) and his plate, (Vol. 2, pl. 70) together with the description makes it certain that these are also species of *Jussiaea*, as might have been expected.

Number (5), with small flowers, is evidently a species of Tournefort. It was afterward referred by Linnaeus to *Oenothera fruticosa*, (Sp. Pl. p. 346). The plant which Linnaeus meant to indicate by this designation was, however, not what we now know as *O. fruticosa*, L., which belongs in a different group, but *O. muricata*, L. as now known. This is shown by Barrelier (1714), who cites Tournefort's *Onagra angustifolia*, *caule rubro*, *flore minore* as a synonym for his *Lysimachia angustifolia*, *spicata*, *lutea*, *Lusitanica*, with a figure (990). This figure is reproduced in plate 3 of this paper, and in comparison with the figure

989, which illustrates one of the *O. biennis* forms, indicates that one of the forms of *O. muricata*, L. was intended, having smaller flowers and narrower leaves than *O. biennis*. Tournefort's species (5) therefore clearly refers to the present *O. muricata* L.

In (4) the reference "H. R. Par." is to *Hortus Regius Parisiensis*, 1665, which is merely a catalogue of polynomials. "Mor. H. R. Bles." refers to Morison's *Hortus Regius Blesensis*, 1669. Here (p. 126) is the earliest recognition I have found of a large-flowered and a small-flowered form. In addition to *Lysimachia lutea corniculata* of Bauhin's *Pinax* (which is nearest *O. Lamarckiana*, as I shall show later) are listed two forms which were introduced into the London Garden between 1655 and 1660. These are named *Lysimachia corniculata minor lutea Canadensis* and *Lysimachia lutea flore globoso*, Park. Ger. On page 284 of the same work Morison says further, "*Lysimachia Corniculata, lutea Canadensis minor seu angustifolia*: Haec sola foliorum angustia, aliarum suarum partium; horum scilicet & capsularum seminalium, parvitate differt, a *Lysimachia Corniculata lutea majori Cornuti*." This form with narrower leaves and smaller flowers probably belonged to *O. biennis*, or possibly to *O. muricata*, but in the absence of figures I have not been able to trace it further.

To return to Tournefort, in (3) "Cat. Altdorf." refers to Hoffman's *Flora Altdorffina*, 1677, which I have not seen. This plant is undoubtedly a large-flowered *Oenothera* from Virginia, and I am strongly inclined to think that it belongs with *O. grandiflora*. The reasons for this will be given later.

The reference "H. L. Bat." in (2) is to Hermann's *Horti Academici Lugduno-Batavi Catalogus*, 1687, in which are cited *Lysimachia lutea corniculata non papposa Virginiana major* and *Lysimachia lutea corniculata non papposa Virginiana minor* from Morison's *Plantarum Historiae Universalis Oxoniensis*, Part II, p. 271, (1680). In the latter work Morison gives a lengthy description of the former and refers to the large yellow flowers. I shall show later that this is close to *O. Lamarckiana* Ser. while the other is undoubtedly a form of *O. biennis* L., probably the "European biennis," which has flowers somewhat larger than our American forms.

The reference to "C. B. Pin." in (1) is to Bauhin's *Pinax Theatri Botanici*, first edition 1623. This plant was also certainly nearer *O. Lamarckiana* than anything else, as I shall show later.

It will be well now to trace chronologically some of the early records regarding *Oenothera*. I have not attempted to hunt down every reference nor see every plate. But the accuracy of our present knowledge

of the forms we call *O. biennis* L., *O. Lamarckiana* Ser., and *O. grandiflora* Ait., enables one to decide definitely in many cases which form is referred to in the early descriptions and plates, and in this way a much more accurate knowledge of the history of these forms in Europe can be attained.

The earliest figure of an *Oenothera* which I have seen is in Alpin's *De Plantis Exoticis*, 1627. This book was published in Venice, and the plants were grown from seeds obtained from an English physician and "philosopher." There is a description (p. 325) under the name *Hyoscyamus Virginianus* and a crude line-drawing which, with the description, leaves no doubt that this is a large-flowered evening primrose; and it came from "Virginia." The extremely long hypanthia in the drawing are probably exaggerated, but the statement in the description, "Ex singulis vero alarum foliorum cavis exibat petiolus digitali longitudine fere" shows that the flower must have approximated closely to the size of our present large-flowered forms. See plate 1.

The earliest reference to North American *Oenotheras* seems to be in Caspar Bauhin's *Pinax* (1623) published at Basil. Here (page 245) he enumerates, with polynomials, eighteen species of *Lysimachia*. His sub-section *Lysimachia lutea* includes some species still retained in *Lysimachia* and also *Oenothera biennis* L.; his sub-section *Lysimachia siliquosa* is our genus *Epilobium*; and his *Lysimachia spicata* and *non-spicata* include species of *Lythrum*, *Veronica* and *Scutellaria*. The *Oenothera* form is described as follows:—

Lysimachia lutea corniculata.

Lysimachiae Virgineae nomine ipsum semen Patavio missum quod anno 1619. in horto eleganter crevit & ex semine deciduo se facile hactenus propagavit.

This reference to p. 245 of Bauhin's *Pinax* is the only one quoted in most of the later citations. One of the copies of the *Pinax* (1623) found in the library of the Missouri Botanical Garden contains a marginal note describing the plant represented by Bauhin's *Lysimachia lutea corniculata*. The owner of this volume who evidently inserted these and other marginal notes, was Joannis Snippendale who I have since learned, (see Andrews, 1910) was about this time connected with the Botanical Garden at Amsterdam. A note on this subject was published in *Science* (1910). I have since found the source of the Snippendale manuscript. It is to be found printed in an appendix to the *Pinax*, p. 520, and therefore the description, which was especially long and detailed for the time, refers

to plants grown by Bauhin, presumably at Basil.¹ The description mentions that the plants were obtained from Padua (the first botanical garden founded in Europe) and grown in 1619, and the description was evidently written from the living plants. This fixes with certainty the date on which the observations were made, and also shows that the *Lysimachia lutea corniculata* of Bauhin must be placed in the series of forms coming under *Oenothera Lamarckiana*, Ser., though not identical with that form in the strict sense. The text of this description of Bauhin, which is appended, together with a translation, reveals the fact that a form very similar to *O. Lamarckiana* Ser. was originally a wild species in Virginia, and that it was the first Evening Primrose to be taken to Europe.

V. *Lysimachia Lutea Corniculata*: planta est ramosa ad viri altitudinem assurgens, forma ad Lysimachiam latifoliam purpuream siliquosam accedens: haec ex radice oblonga alba, digitalem crassitudinem superante, paucis fibris capillata, caulis exsurgit initio rotundus, at supra medium, ob plurimos ramos angulosus, subcinereus, laevis, statim a radice in breviores, mox majores ramos, hique in alios late expansos, brachiatus, qui rotundi paucissimis pilis donati, hinc inde maculis parvis rubentibus variegati, ex quibus tanquam ex poris pilus prodit. Folia statim ad radicem plura, oblonga, palmum superantia, latitudine unciam vix excedentia, quae crassa, pallide virentia, laevia in acutum desinentia; quorum inferiora quandoque lacinata, reliqua vero obscure sinuata, per quorum medium costa alba, ut in Lysimachia Chamaenerion dicta, excurrit; ex alarum sinibus pediculus articulatus et rotundus prodit, cujus pars supra articulum triuncialis fistulosa, cui flos magnus, flavus quadrifolius extra folia effertur: qui cum primo florere incipit, quadrangulus est, quo aperto verum Sole tantum lucente, in ejus medio stilus conspicitur, qui viridis ad articulum usque descendit, et apicibus quatuor sulphurei coloris, crucis in modum dispositis, donatus est, quem stamina octo circumstant, quorum quatuor singulis foliis adposita, alia quatuor ipsis interjecta sunt; hisque singulis capitulum oblongum albicans insidet: ipsi vero flori, calycis in modum, folia quatuor oblonga, angusta, pallida subjiciuntur. Flos odoratus est, nonnihil ad Keiri,¹ vel potius Lillasphodeli lutei odorem accedens, ultra diem non persistens, cum is qui sub vesperam aperitur, ad sequentis diel vesperam flaccescat, unde Ephemerum dici meretur. Flore, cum pedicello ad articulum delapso, altera pediculi pars sesquiuncialis, sensim ad uncias binas, etiam ternas oblongatur et in siliquam sive corniculum abit, et propter semen copiosum, nigrum, parvumque, quod continet, intumescit; quod ubi maturuit, ipsa cornicula, quae utrinque ad caulis latera numerosa sunt. in quatuor partes dividuntur. Hujus semen, Lysimachiae Virginianae nomine Anno 1619. Patavio accepimus, quod Vere satum, tota aestate et hyeme sine caule remansit: at sequenti anno, circa Veris finem calescere, et Junio florere coepit; nunc vero ex deciduo semine (annua enim planta est) autumnio delabente, singulis annis in hortulo meo copiose et usque in autumnii finem floret.

¹Curiously enough, most of the later citations of the *Pinax* refer only to page 245. and for this reason the existence of the description in the appendix, which Snippendale evidently copied, was at first overlooked.

¹Probably *Cheiranthus cheiri* of Willd. *Sp. Pl.* 3:516.

Matthioli Ephemerum esse suspicatus sum, sed cum nullas, nisi Dioscoridis, notas, adposuerit, nil pronunciare licet.

English Translation.

Lysimachia lutea corniculata is a branchy plant rising to a man's height. Its shape resembles *Lysimachia latifolia purpurea siliquosa*.¹ It (comes up) from an oblong white root, thicker than the finger, bearing a few fibres. The stem rises round at the base, and above the middle becomes angular on account of the many branches, (is) subcinereous, smooth, branches out right from the root into rather short branches, soon becoming longer, and these branch into others broadly spread out, which (and these) are round (and) supplied with a very few hairs, (and) dotted with small reddish spots, from which, as from pores, a hair protrudes. There are many leaves right at the root, oblong, longer than the palm of the hand, (but) scarcely exceeding an inch in width. These are thick and pale green, slender (and) end in a point; the lower ones are sometimes lacinate, the others in truth obscurely sinuate. Through the midst of them runs a white rib, as in the aforesaid *Lysimachia chamaenerion*.² From the curves of the wings (i. e. from the axils of the leaves) a jointed round pedicel comes forth, of which the part above the joint is three inches³ long and hollow. On this a big yellow, four-petalled flower, flares out beyond the leaves. When it first begins to flower, it (the bud) is quadrangular, and opening when the sun is still barely shining, in the midst of it is seen a pistil, which (is) green (and) goes down all the way to the joint, and is furnished with four apices, sulphur-colored and arranged in the form of a cross, around which stand eight stamens, four of which are placed one opposite each petal. The other four are set in between the first (four). On each one of these sets a small whitish head. Four oblong, narrow, pale leaves are set in underneath the flower itself, in the form of a calyx. The flower is fragrant, not unlike the Keiri, but rather more like the odor of the yellow liliaphodel. (It) does not last beyond one day, and when it opens towards evening it wilts on the evening of the following day, from which it deserves to be called Ephemerum, when the flower with its pedicel has fallen off at the joint, the other part, measuring an inch and a half,¹

¹A species of *Epilobium*.

²Probably *Epilobium angustifolium* L.

³It is probable that the dimensions stated are only approximately correct and cannot be taken as accurate measurements. In none of these forms, for example, is the hypanthium three inches in length, but such a measurement would answer approximately for the combined length of hypanthium and cone, which is probably referred to here. Similarly, the width of the rosette leaves, given as scarcely more than an inch, is probably only an approximation. The measurement given for the length of the ovary, viz.: 1½ inches, must surely be incorrect.

⁴This must be an error. Half an inch would be more nearly correct for any *Oenothera* of this group comprising *O. Lamarckiana*, *O. grandiflora* and *O. biennis*.

gradually elongates to two or three inches, and grows into a pod or little horn, and swells out because of the abundant little black seeds that it contains. When it (the seed) is ripe, the little horns, which are thickly set on both sides of the stem, are divided into four parts. We received this seed, *Lysimachia virginiana* by name, from Padua in the year 1619, and when it was sown in the spring, it remained the whole summer and winter without a shoot. And the following year it began to send up shoots about the end of spring, and to flower in June: now from the seed falling in the autumn, (for it is an annual plant), it flowers abundantly every year in my little garden until the end of autumn. I suspect it to be Matthioli's *ephemerum*,² but since he has stated that there are none known unless those of Dioscorides, there is nothing which permits me to decide.

To enable the reader to follow these records intelligently I should here state that, as the result of cultures of numerous races of *O. grandiflora* and *O. Lamarckiana* forms, derived from various sources, as well as from the work of MacDougal, Miss Vail, and others (1907), (see Gates 1909) the main differentiating characters between the two series of forms are seen to be (1) the buds of the former are rounded instead of quadrangular, more slender, with thinner sepals and usually more slender and setaceous sepal tips than *O. Lamarckiana* forms. (2) The leaves of the mature rosettes in *O. grandiflora* have conspicuous basal lobes and are thinner than in any *O. Lamarckiana* forms. (3) Physiologically the *O. grandiflora* forms agree in partly or wholly omitting the rosette stage, under the same conditions of culture in which it is almost invariably well-developed in all the *O. Lamarckiana* forms.

The characters described which serve to identify this plant of Bauhin may now be considered. (1) The presence on the branches, of little red dots, each with a hair arising from it. *O. Lamarckiana* and all its mutants, as well as *O. biennis*, have a long type of hair,—the one mentioned here,—which is much longer and stouter than the other type and which always arises from a little papilla, the latter being usually red. This type of hair also occurs on the stems of the *O. grandiflora* from Alabama, but I have reason to believe that it is much less common and frequently absent from *O. grandiflora* in its Eastern range. This belief is based upon studies of the *O. grandiflora* forms now growing wild in certain parts of England, which very probably are descended from plants introduced from Virginia at an early date. (2) The rosette leaves are described as oblong, hardly more than an inch in width, thick and pale green, slender and pointed. The lower leaves of the rosette are said to

²This is probably *Lysimachia ephemerum* of Willdenow's *Sp. Pl.* 1:817.

be sometimes laciniate, the others obscurely sinuate. A careful study of this description, and comparison with the rosette stages of *O. Lamarckiana* and *O. grandiflora* forms, leads me to the conclusion that it undoubtedly could not have referred to *O. grandiflora*, because the leaves are described as long and narrow, thick and pale green, while in *O. grandiflora* the leaves are not only broad and darker green, usually mottled with red, but are thin and comparatively delicate. The conspicuous lobes or lacinations at the bases of the leaves of the mature rosette, which seems to be characteristic of all the *O. grandiflora* forms, might at first be thought to be indicated by the words "inferiora quandoque laciniata." but these words would refer more correctly to the inconspicuous lobes or projections not infrequently found near the base of the blade in *O. Lamarckiana* and others of that series. Taking the rosette characters *tout ensemble*, they certainly in my judgment picture a plant of the *O. Lamarckiana* series, while they could not reasonably be held to refer to any form in the *O. grandiflora* series. Therefore, regarding *O. Lamarckiana* as a "Linnaean" species, this form should be included within it. On the other hand the description differs in several respects from the typical *O. Lamarckiana* of cultures. There is no mention of the crinkling of the leaves, but I shall show that this is referred to in an independent description of what was probably the same form. The rosette leaves, if only an inch in width, are certainly much narrower than is usual in our *O. Lamarckiana*.¹ (3) The fact that the hypanthium or flower stalk is about three inches long and the flower large, of course precludes the plant from being *O. biennis* or any other small-flowered form. (4) The statement that the bud is quadrangular is important because it again eliminates *O. grandiflora* as a possibility. The third character referred to then distinguishes the plant from *O. biennis*, while either the rosette characters or the quadrangular buds are sufficient to make it certain that the plant cannot be *O. grandiflora*. The only other species which is a possible candidate for this position is *O. argillicola* McK. The rosette leaves of the latter are very narrow but, though its flowers are large, several other characters, such as the rounded bud and the more or less decumbent stem and branches throw this out of court as a possibility. While the plant described in this earlier account is therefore closer to *O. Lamarckiana* Ser. than to any other form, and cer-

¹It has occurred to me that these rosette leaf characters might compare very well with *O. laevifolia*. Is it possible that *O. laevifolia* is not a mutant from *O. Lamarckiana* but has persisted continuously in collections of seeds, since this earliest introduction? If so, it would probably be the form referred to in the Hort. Cliff. (1737) as growing abundantly on the sand dunes of Holland. Against this interpretation is the fact that plants growing on the English coast near Liverpool from an early date, contain the true *O. Lamarckiana* as a prominent constituent of the population, but are not found to contain *O. laevifolia*.

tainly agrees with the latter in all essentials; yet it seems evident that the rosette leaves were narrower than in our type. Moreover, according to the description, there were also secondary branches developed, which is not usually the case in our present *O. Lamarckiana*. The plants are also said to be the height of a man, which is rather higher than *O. Lamarckiana* averages in cultures. I shall show later that the *O. Lamarckiana* now growing wild on the coast north of Liverpool, England, must have originated from the early introduction of *O. Lamarckiana* from Virginia, while the *O. Lamarckiana* of DeVries' cultures is known to have come from Texas. In this connection it may be worth noting that this English *O. Lamarckiana* in my cultures attains a somewhat greater height than the plants of DeVries grown under the same conditions. These differences, however, are of quite minor value and the important features, such as the red papillae on the stem, the general shape of the rosette leaves, the large flowers and quadrangular buds, make it certain that the plant described by Bauhin cannot be excluded from *O. Lamarckiana* Ser. and placed with one of the other species.

This appendix to Bauhin's *Pinax* contains the oldest description of a North American *Oenothera* known to exist. Certainly very few American plants, if any, received so accurate a description at such an early date. As an early historic record of the plant this is about all that could be asked for; and it is certainly much more complete and accurate than could have been expected. It shows that the claim frequently made, that *O. Lamarckiana* originated in cultivation, either through crossing or in any other way, is without sufficient foundation. There has been so much obscurity and doubt regarding the origin and early history of *O. Lamarckiana*, that a description which proves that a plant closely resembling it, at least, originally grew wild in "Virginia" and was the first Evening Primrose introduced into Europe, must be regarded as of prime importance as an historical record. The fact that the details of De Vries' Mutation Theory have been conceived on the basis of the behaviour of this plant, gives every item of its early history an added import. It should be stated that the fact that *O. Lamarckiana* was originally wild does not preclude its having arisen in nature through the crossing of races, although this is improbable for other reasons; nor does it show that crossing has not taken place since its introduction into gardens, for undoubtedly such crossing has taken place. But a discussion of these questions is not germane to the present subject, which is merely to trace the historic record of these plants. In regard to this earliest record it should be pointed out that this form could not have

arisen by crossing during the five years between 1614, when the plants are first said to have been introduced, and 1619, because a single (large-flowered) type was introduced and there was nothing with which it could cross. The earliest record of a small-flowered form I have found in Morison's *Hortus Blesensis* in 1669, previously referred to.

In looking through the later works of Caspar Bauhin, and especially the *Historia Plantarum Universalis* of John Bauhin, I have found no further mention of *Lysimachia lutca corniculata*. In the last mentioned work, Vol. II, pp. 901-908 (1651), the *Lysimachias* are described and figured, but this plant is not included, most of the species described being evidently *Epilobiums*. Its absence cannot be ascribed to its being an exotic, for a "*Lysimachia*" from Argentina in 1595 is described.

In summing up the case it may be said that the references, in the description, to the large flowers, the quadrangular buds, and the shape and other features of the rosette leaves, remove this plant with certainty from either *O. biennis* or *O. grandiflora*. The only discrepancies with *O. Lamarckiana* as we now know it are (1) the rosette leaves scarcely exceeding an inch in width. But this may be an error, because the reference to ovaries an inch and a half long is evidently an error. However, Parkinson, in his *Paradisus*, also refers to the rosette leaves as "long and narrow pale green leaves," so that it seems probable that this plant had narrower and paler green rosette leaves than the one we now cultivate. There also appears to be no mention of the crinkling of the rosette leaves. (2) Secondary branches are not usually formed in our plant, although they may occur. These minor differences are, however, certainly of much less importance than the similarities already pointed out.

The next reference that I have examined is in Parkinson's *Paradisus*, 1629. From his accompanying figure it is uncertain whether the flowers are large or small, but in his *Theatrum Botanicum* (1640) p. 548, he gives a better figure, which shows that this is undoubtedly a large flowered *Oenothera*. His quaint description is as follows:

Lysimachia lutea siliquosa Virginiana. The tree primrose of Virginia.

Unto what tribe or kindred I might referre this plant, I have stood long in suspense, in regard I make no mention of any other *Lysimachia* in this work: lest therefore it should lose all place, let me ranke it here next unto the Dames Violets, although I confesse it hath little affinity with them. The first yeares of the sowing the seede it abideth without any stalke or flowers lying upon the ground, with divers long and narrow pale green leaves, spread sometimes round almost like a Rose, the largest leaves being outermost, the very small in the middle: about May the next yeare the stalke riseth, which will be in Summer

of the height of a man, and of a strong bigge size almost to a man's thumbe, round from the bottome to the middle, where it groweth crested up to the toppe, into as many parts as there are branches of flowers, every one having a small leafe at the foote thereof; the flowers stand in order, one above another, round about the tops of the stalks, every one upon a short foot-stalke, consisting of foure pale yellow leaves, smelling somewhat like unto a Primrose, as the colour is also (which hath caused the name) and standing in a greene huske, which parteth it selfe at the toppe into foure parts or leaves, and turne themselves downewards, lying close to the stalke: the flower hath some chives in the middle, which being past, there come in their places long and cornered pods, sharpe pointed at the upper end, and round belowe, opening at the toppe when it is ripe into five [?] parts, wherein is contained small brownish seed; the roote is somewhat great at the head, and wooddy, and branched forth diversely, which perisheth after it hath borne seeds."

He also states that the plant "came out of Virginia."

This is very evidently the same plant as the *Lysimachia lutea corniculata* of Bauhin, though an independent description.

Robert Morison in his *Plantarum Historia Universalis Oxoniensis*, Vol. II., published at Oxford in 1680, used the description of Bauhin as the basis for his description of the same plant. Many parts are repeated word for word, even one or two errors being perpetuated in this way; but there are also a number of minor changes in the order of description and in the order of words, several additions tending to complete the description, and one or two corrections. These will be seen on comparing the Latin of the two descriptions. Morison's description of this and a second (small-flowered) species (p. 271) is as follows:

Lysimachia lutea corniculata non papposa.

7. *Lysimachia lutea corniculata non papposa* Virginiana major, nobis. *Lysimachia lutea corniculata* C. B. P. *Lysimachia siliquosa* Virginiana, Park. Haec *Lysimachia peregrina* non multis abhinc annis ex Virginia aliisque Americae Septentrionalis partibus, seminibus in Angliam delata & hic sata, ad cubitalem & bicubitalem aliquando altitudinem provenit: folia habet prima glauca, longa, orbiculariter per terram strata, sinuata, mucronata, palmum superantia, latitudine vix unciam excedentia quae sunt crassa, laevia, pallide virentia, & in acutum mucronem desinentia, per quorum medium costa alba, ut in *Lysimachia Chamaenerion* dicta, excurrit: praedicta folia exeunt ex radice longa, alba, digitalem crassitudinem superante, paucis fibris capillata; caulis exsurgit initio rotundus, at supra medium ob plurimos ramos angulosus, subcinereus, laevis statimque in breviores, mox majores qui rotundi paucissimis pilis donati, hinc inde parvis maculis rubentibus variegati, ex quibus tanquam ex poris pilus exilit. Ex alarum sinubus pediculus articulatus & rotundus prodit, cujus pars supra articulum triuncialis, fistulosa, cui flos magnus, flavus, quatuor petalis constans, extra folia effertur, qui cum primo florere incipit, quadrangulus est, quo aperto vel sole tantum lucente in ejus medio stilus conspicitur, qui

viridis, usque ad articulum descendit, & apicibus quatuor sulphurei coloris, crucis in modum dispositis donatus est, quem stamina octo circumstant, quorum quatuor singulis foliis apposita, alia quatuor ipsis interjecta sunt: hisque singulis capitulum oblongum albicans insidet: ipsi vero flori calycis in modum foliola quatuor, oblonga, angusta, pallida, subjiciuntur: flos odoratus est, nonnihil ad keiri vel potius Liliaphodeli lutei odorem accedens, ultra diem non persistens, cum is qui sub vesperam aperitur ad sequentis diei vesperam flaccescat, unde Ephemerum dici meretur. Flore cum pedicello dilapso altera pediculi pars sesquiuncialis sensim ad uncias binas, etiam ternas, oblongatur, & in siliquam seu corniculum abit, & propter semen copiosum, nigrum aut fuscum parvumque, quod continet, intumescit, quodque ubi maturuit, ipsa cornicula, quae utrinque ad caulis latera numerosa sunt, in quatuor partes dividuntur: ex semine sato tota aestate & hyeme sequente sine caule remanent plantae folia per terram strata; at sequenti anno circa Veris finem calescere, & Junio florere incipit, & floret & semina perficit in Autumni finem, atque cum sit biennalis planta ex semine deciduo Autumno dilabente, singulis annis in hortis nostris copiose conspicitur sine caule, adventante secundo Vere caulem erigit & semina sua perficit.

8. *Lysimachia lutea corniculata* non papposa Virginiana minor, nobis. Haec in omnibus priori convenit, nisi quod folia producat dimidio minora & angustiora; flores pariter dimidio aut saltem multo minores, nec tam alte ascendunt caules; in caeteris omnibus majori convenit.

English Translation.

LYSIMACHIA LUTEA CORNICULATA NON PAPPOSA.

7. *Lysimachia lutea corniculata* non papposa Virginiana major, our (species). *Lysimachia lutea corniculata*, C. B. P. *Lysimachia siliquosa* Virginiana, Park. This *Lysimachia*, a foreign (plant), was brought by seed not many years ago from Virginia and other parts of North America to England and sown here. It attained a height of one or two ells. It has at first long glaucous leaves, spread out in a circle over the ground, sinuate, mucronate, longer than the palm (of the hand), hardly more than an inch in breadth, which are thick, smooth, pale green, and end in a sharp point. Through the middle of them runs a white rib, as in *Lysimachia Chamaenerion* aforesaid. These same leaves come forth from a long, white root, thicker than the finger, bearing a few fibres. The stem rises round at the base, and above the middle becomes angular because of the many branches, (is) subcinereous, slender, and immediately branches into rather short branches, soon (growing) larger, and these (branch) into others broadly spread out, which are round (and) covered with a few hairs, and dotted with small reddish spots, from which as from pores a hair springs forth. From

the curves of the wings a jointed round pedicel comes forth. The part of this above the joint is three inches long and hollow. On this a large yellow flower, having four petals, stands out beyond the leaves, (and) when it first begins to flower, it is quadrangular. When open or the sun shines brightly a pistil is seen in the midst of it, which (is) green (and) goes down all the way to the joint, and is furnished with four sulphur-colored apices arranged in the form of a cross. Around this stand eight stamens, four of which are placed one opposite each leaf, the other four are set in between the first (four): and on each one of these sets an oblong whitish little head. Underneath the flower itself four little leaves, oblong, narrow, (and) pale, are set. The flower is fragrant. Its odor is not unlike (that of) the Keiri but rather more like (that of) the yellow Liliashodel. It does not last beyond one day, (but) when it opens toward evening it wilts on the evening of the following day. whence it deserves to be called Ephemeron. When the flower with its pedicel has wilted down, the other part of the pedicel, an inch and a half long, gradually elongates to two or even three inches, and grows out into a pod or little horn, and this swells up on account of the abundant, black or fuscous, little seeds that it contains; and when it (the seed) is ripe, these same little horns, which are thickly set on both sides of the stem, are divided into four parts. From the seed sown, the plants remain the whole summer and the following winter without a shoot, the leaves spread out over the ground, and the following year, about the end of spring, it begins to send up shoots, and in June to flower, and it flowers and perfects seeds towards the end of autumn. and since it is a biennial plant, from the seed that falls in the autumn. every year it is seen abundantly in our gardens without a stalk. With the coming of the second spring it erects a stalk and perfects its seeds.

It will be seen that Morison gives both species new names and describes them as his own.

If we now make a comparison of the 1619 account of this plant, with the 1680 description, on comparing the Latin, it will be seen that there are a number of additions to the later account. The plant is now found in other parts of North America than Virginia. The sequence of the description has been transposed, the account of the rosette leaves coming first, in logical order. The changes introduced are in many cases corrections of inaccuracies. Thus, in regard to the rosette leaves, "oblonga" is changed to "longa"; "obscure sinuata" becomes "sinuata": "mucronata" is added; "glaucæ," referring to the rosette leaves, doubtless has the post-Augustinian Latin meaning "bluish gray," in

this case due to pubescence and not to a "bloom" or coating of wax as in modern botanical usage; "quandoque laciniata" of Bauhin's description is omitted entirely as being, perhaps, too infrequent or inconspicuous to find a place in the description.

In regard to the flower, "quadrifolius" becomes "quatuor petalis constans"; "folia," "foliola"; in regard to the seeds, "nigrum" becomes "nigrum aut fuscum," which is much more nearly correct. "Exilit" is perhaps more appropriate than "prodit" applied to the hairs on the stem. Some errors are also perpetuated. Thus, perhaps "latitudine unciam vix excedentia" applied to the rosette leaves; probably "albicans" applied to the anthers; certainly "sesquiuncialis" applied to the length of the ovary at the time the flower falls. The term "non papposa" in the name presumably contrasts *Oenothera* with the capsule characters of *Epilobium*.

Morison also gives figures of the two species (*Plant. Hist. Tab. 11, Sec. 3*) under the names *Lysimachia Virginiana latifolia lutea, corniculata, nobis*, Fig. 7 (with large flowers) and *Lysimachia Virginiana angustifolia, corniculata, nobis*, Fig. 8 (with small flowers). Figures of single flowers are also given, the diameter of the large flower being represented as exactly three times that of the small one. These figures are photographed and reproduced in plate 2.

Six years later, in 1686, John Ray in his *Historia Plantarum*, Vol. I., p. 862, gives a similar description, partly copied from Morison, but with many amendations and additions, and the omission of the rosette characters. The original, which is given here for comparison with the earlier descriptions, is as follows:

10. *Lysimachia Lutea Virginiana* Ger. emac. *lutea siliquosa Virginiana* Park. *lutea cerniculata* C. B. APP. TREE PRIMROSE. *Lys. Americana* Col. *Arochioti* Hernandez.

C. B.

Ex radice oblonga, alba, digitalem crassitudinem superante, paucis fibris capillata caulis exurgit initio rotundus, at supra medium ob plurimos ramos angulosus, subcinereus, laevis [hirsutus,] crassitudine digitali, medulla fartus, & superius punctis rubentibus varie notatus. Folia longa, angusta, in caule crebra, alternatim posita, ad margines sinuata & obiter dentata. Flores Lysimachiae modo summis siliquis insident magni, tetrapetali, lutei, Primulae veris floribus similes, e calice quadrifolio, pediculo rotundo, articulo donato. In medio flore stylus conspicitur, qui viridis usque ad articulum descendit, & apicibus quatuor sulphurei coloris crucis in modum dispositis donatus est, quem stamina octo circumstant, quorum quatuor singulis foliis adposita, alia quatuor ipsis interjecta sunt; hisque singulis capitulum oblongum albicans insidet. Flos odoratus est, ultra diem non persistens, cum is qui sub vesperam aperitur ad sequentis diei vesperam flaccescat, unde Ephemeron dici meretur.

Flore cum pedicello ad articulum delapso altera pediculi pars sesquiuncialis, sensim ad uncias binas, etiam ternas, oblongatur, & in siliquam sive coniculum abit, & propter semen copiosum, parvum, angulosum, pullum quod continet, intumescit; quod ubi maturuit, ipsa cornicula, (quae utrinque ad caulis latera numerosa sunt) in quatuor partes dehiscunt, quaternis loculamentis quatuor seminum ordines continentia, nulla intus lanugine seminibus adhaerescente. [In singulis foliorum alia singuli flores sedent; cornicula sessilia pediculis carent, ad basin crassiora, sensim versus apicem tenuiora, raris pilis hirsuta.]

Plantam hanc *Lysimachiae Americanae* titulo describit & depingit F. Columna, Annotat. ad *Res medicas Novae Hispan.* Nard. Ant. Recchi: & *Azochioli* seu *Florem aquae* praedicti Recchi seu Hernandez, lib. 7. cap. 48, *Hist. Mexicana* descriptum & depictum esse existimat, quod & nobis etiam videtur.

Prima qua sata est aestate caulem non edit, verum anno sequente, semine autem ad maturitatem perducto radicitus exaerescit.

Camaranbaya Brasiliensis altera species *Marggr.* huic eadem esse videtur.

11. *Lysimachia Virginiana* altera, foliis latioribus, floribus luteis majoribus Cat. Altdorf.

Hae praecedente elatior est & major, ut quae humanum interdum altitudinem multum superet,¹ foliis latioribus, & pro magnitudine brevioribus, ad margines minus sinuatis & propemodum aequalibus: floribus etiam multo amplioribus.

In hortis nostris frequentior est praecedente.

Among the many changes in description 10, from the Morison description may be pointed out the insertion of the word "hirsutus," which characterizes the stem better than "laevis"; the word "angulosum" is added to the description of the seeds, and "pullum" substituted for "nigrum aut fuscum." The capsule is more fully described, and the clause "nulla intus lanugine seminibus adhaerescente" contrasts it with the species of *Epilobium*.

The reference to Hernandez was found to be an independent (earlier account of a plant which appears to have been *O. Lamarckiana*. This is the only description I have found in which the crinkling of the leaves is described. In Hernandez's *Nova Plant. Anim. et Miner. Mex.*, published at Rome in 1651, this important independent description is given (p. 882) as follows:

Lysimachia Americana.

Primae iconis plantam, ni fallimur, vel illi admodum similem, satam habemus ex Virginia Novi Orbis allatam, & sub nomine *Lysimachiae luteae* a doctiss. Johanne Pona Veronense nobis cum alijs rarioribus dono missam, cuius flores (pictoris forsan incuria in summo non dense depicti) siliquis insidentes apparent, longo lobulo prodeuntes lutei, qui crescente caule paulatim inter foliorum

¹In a recent visit to St. Anne's-on-the-Sea, on the coast near Liverpool, England, where many large-flowered *Oenotheras* have been growing wild for a century at least, I observed one rather constant race which seeded itself in an unused back-yard. Its average height exceeded that of a man, and its flowers were correspondingly very large. The other characters were intermediate in some respects between *O. Lamarckiana* and *O. grandiflora*, but much nearer the former.

sinus alternatim, & in spicam disponuntur: marcescentibus vero illis crassescunt siliquae quadratae, duas uncias longae, durae, & perfectae, in quatuor partes dehiscentes: copiosa intus, parva, angulosa, fusca, insipida semina continentes, & facile, vento agitata planta, decidentia, ut necesse sit cum incipiunt dehiscere, colligere. Augusto floret, & Septembri perficitur. Folia sapore insipido, quae prima facie Keiri sive luteae *Violae* similia videntur, sinibus levibus excavata, quae in caule vix sinuosa apparent, ut facile salignis equiparari potuerint. Flores fructui insident longo tubulo, foliato capite, qui est quatuor foliolis constructi sint, non tamen ideo cum Keiri aliquid commune habent, siliqua non bivalvi, non capitata, nec semina compresso: nec etiam cum vera *Lysimachia* folijs inordinatis, non ternis, nec adstringentibus: fructu diverso cum siliquosa dicta sive *Chamaenerio* non parum, nisi semina huic non papposa essent. Planta est levifolia, radice longa parum, & fibrosa, lignosa, quae regerminare solet. Iconem expressam addimus. Aliam ejusdem nominis plantam bulbosa radice, infra reperies alterius generis fol. 257.

The accompanying figure is that of an *Oenothera* with large flowers and the stigma projecting beyond the stamens. The branching of this plant is somewhat unusual, if correctly represented. There are no basal branches, but a few long branches near the top. However, I have seen plants in cultures with this type of branching, and there is so much difference in branching, under different conditions of growth, that this point is of little significance. The point of greatest interest in this description is the statement regarding the leaves, "sinibus levibus excavata." This clearly describes the characteristic crinkling of the leaves of *O. Lamarckiana*, and leaves little, if any, doubt that this plant was *O. Lamarckiana* in the strict sense. The upper leaves on the stem were evidently smooth, as is usually the case in our *O. Lamarckiana*. The comparison with *Salix* leaves may indicate that they were somewhat narrower than typical *O. Lamarckiana*.

Regarding the origin of these seeds, which were obtained from John Pona in Verona, it is not clear whether the latter had obtained the seeds direct from Virginia or had grown several generations of the plants before sending seeds to Hernandez. This leaves open the possibility that crosses might have taken place in the meantime, but if they did, the same crosses might have taken place in Virginia among the wild plants, so that this contingency does not seem to the writer to be of importance.

The reference to fol. 257 is to a figure and description of another plant in *Rerum Med. Nov. Hisp.*, published by the same author in the same year. This is evidently a Mexican species of *Oenothera*. The flowers are described as varying from red to yellow.

To return to the description of Ray's species, number 11, I have concluded probably belongs to *O. grandiflora*. Coming from Virginia, it

differed, as I shall show, in certain respects, from the *O. grandiflora* of Alabama which is now in cultivation. But the broader and relatively shorter leaves and the other characters mentioned seem to refer to this form, although all the distinguishing characters which would lead to certainty are unmentioned. The flowers of the reputed Virginian *O. grandiflora* may be somewhat larger than in *O. Lamarckiana*. Moreover, exceptionally tall and robust plants frequently have correspondingly larger flowers. I shall refer to this again later. It is the earliest description I have seen which could refer to *O. grandiflora*.¹

Tournefort, in his *Institutiones* (1700), recognized large- and small-flowered forms, and in 1714 Barrelier² gives very instructive figures of three species as follows:

- (1) Pl. 989. *Lysimachia latifolia, spicata, lutea, Lusitanica*, with the synonym *Onagra angustifolia* Tourn. Inst. 302.
- (2) Pl. 990. *Lysimachia angustifolia, spicata, lutea, Lusitanica*, with the synonym *Onagra angustifolia, caule rubro, flore minore*. Tourn. Inst.
- (3) Pl. 1232. *Lysimachia lutea, corniculata, latifolia, Lusitanica*, with the synonym *Onagra latifolia, floribus amplis* Tourn. Inst.

The first two species are small-flowered forms, and it is very probable that they represent races of what are now known as *O. biennis* L. and *O. muricata* L. In plate 989 the spike is very dense, while in plate 990 the petals are deeply emarginate, smaller and the rosette leaves narrower than in 989. The rosette leaves have long petioles in both. The third species has much larger flowers, the leaves are represented as markedly repand-denticulate, sometimes more or less curled. Though there is little basis for judgment, the leaves seem to suggest *O. Lamarckiana* rather than *O. grandiflora*. These figures are reproduced in plates 3 and 4.

The *Hortus Cliffortianus*, published at Amsterdam in 1737, gives (p. 144) two species of *Oenothera*, with synonymy as follows, the genus *Oenothera* having been previously characterized by Linnaeus in the *Genera Plantarum*:

1. *Oenothera foliis ovato—lanceolatis denticulatis, floribus lateralibus in summo caulis.*

Onagra latifolia Tournef. Inst. 302.

Lysimachia lutea corniculata Bauh. pin. 245, 516.

Lysimachia lutea corniculata non papposa virginiana major. Moris. Hist. 2 p. 271.

¹Since writing this I have noticed that L' Heritier, in his description of *O. grandiflora* (see L' Heritier MS) says "Conf. *Onagra latifolia floribus amplis*. Tourn. inst. 302," which clearly confirms my conclusion.

Lysimachia lutea corniculata latifolia lusitanica Barr. rar. t. 1232.

Onagra latifolia, floribus amplis Tournef.

Onagra latifolia flora dilutiore Tournef.

Crescit in Virginia aliisque Americae locis.

It is interesting to note that even at this time he says "Copiose crescit ubique in campis arenosis Hollandiae."

2. *Oenothera foliis lineari-lanceolatis dentatis, floribus e media caule.*

Onagra angustifolia, caule rubro, flore minore. Tournef. Inst. 302.

Onagra salicis angusto dentatoque folio, vulgo Mithon. Fevill peruv. 3, p. 48. t. 36.

Crescit in America meridionali prope Chili.

The corolla is described as "flavo rubra." I have not attempted to determine what South American species this is. Tournefort's *Onagra angustifolia* is evidently wrongly referred to it.

Linnaeus, in the first edition of the *Species Plantarum* (1753), recognizes three species of *Oenothera* (1:346), *O. biennis*, *O. mollissima* and *O. fruticosa*. The second is a South American form which need not concern us. Tournefort's *Onagra angustifolia caule rubro, flore minore* is referred to *O. fruticosa*. As already mentioned, the figure of Barrelier (990), together with his synonymy, makes it quite certain that the plant here designated by Linnaeus *O. fruticosa* was in reality what we now know under the name of *O. nivicata* L. The modern *O. fruticosa* belongs in the sub-genus *Kneiffia* and has a very different habit, much larger flowers and quite different capsules.

Linnaeus' citation of *O. biennis* in the *Species Plantarum*, 1st Edition, is as follows:

Oenothera foliis orato lanceolatis planis. Vir. Cliff. 33. Hort. Ups. 94.

Gron. virg. 154. Roy. lugdb. 251. Gort. E. gelr. 78.

Oenothera foliis ovato-lanceolatis denticulatis, floribus lateralibus in summo caulis. Hort. Cliff. 144.

Lysimachia lutea corniculata. Bauh. pin. 245, 516.

Moris. hist. 2. p. 271. s. 3. t. 11. f. 7.

Habitat in Virginia unde 1614, nunc vulgaris Europae.

The fact that Linnaeus cites as an illustration Morison's fig. 7 (reproduced in plate 2), which is beyond peradventure a large-flowered *Oenothera*, and ignores all previously published figures of small-flowered species, shows without question that he meant in *O. biennis* to include only the larger flowered forms. Further, he recognizes that Morison's plant is the same as the *Lysimachia lutea corniculata* of Bauhin, which, as I have shown, on account of the quadrangular buds and other characters, undoubtedly belongs in the *O. Lamarckiana* series of forms, and not to *O. grandiflora*. Unquestionably, therefore, Linnaeus meant as

the type of *O. biennis*, one of the *O. Lamarckiana* series of forms, with large flowers, and he excluded and ignored all reference to any of the small-flowered forms, several very good figures of which were already in existence by the same authors who had figured and described the large-flowered forms. In the *Hort. Cliff.* the synonymy as already given (p. 31 MS.) cites in addition to Morison's *Lysimachia lutea corniculata non papposa virginiana major* (which is apparently the same as the plant which he figures under the name *Lysimachia Virginiana latifolia lutea corniculata*), Barrelier's *Lysimachia lutea corniculata latifolia lusitanica* with his figure 1232 (reproduced in plate 4). Barrelier cites as a synonym Tournefort's *Onagra latifolia floribus amplis*, which is, I believe, *O. grandiflora*. The figure itself is indecisive between *O. grandiflora* and *O. Lamarckiana*. Linnaeus, however, in the *Hort. Cliff.*, segregates *Onagra latifolia, floribus amplis* Tournef. as differing from the type of his species. It would, therefore, seem probable that while Barrelier considered his species to be the same as Tournefort's *Onagra latifolia, floribus amplis*, yet Linnaeus decided that Barrelier's plant was the same as Morison's, and that the species of Tournefort was another thing, differing in minor characters. This is in entire accord with our belief that the latter species was really *O. grandiflora*. Moreover, the close similarity of the names under which these plants of Barrelier and of Morrison were figured (differing only in using *Virginiana* for *lusitanica*) would indicate that these two forms were the same. At any rate, it is clear that Linnaeus meant by *Oenothera biennis* the large-flowered forms of *O. Lamarckiana* series, and it is possible, though not probable, that he meant to include *O. grandiflora*.

From this time forward large flowered forms are frequently cited or figured under *O. biennis* L., and, as we have seen, these large-flowered forms were undoubtedly the ones to which the name *O. biennis* was originally applied.

O. biennis is stated by Linnaeus to have been brought from Virginia about 1614. The source of this statement, which other evidence shows must be about true, I do not know, but it has frequently been quoted in other works. In the *Hortus Upsaliensis*, (1748) Vol. I, p. 94, Linnaeus says with reference to the plant which he afterwards called *O. biennis* in the *Species Plantarum*, "Habitat in Virginia circa 1620, in Europam translata, nunc in Belgio, Italia, Gallia, Germania spontanea," showing the wide distribution of these forms at that early time, a century after their first introduction.

Miller in the *Gardener's Dictionary*, 6th Edition (1752), under *Onagra* cites 12 species. Regarding the first, *Onagra latifolia* Inst. R. H.

or broad leav'd Tree-primrose, he says, "The first sort is very common in most English gardens, where, when it has been suffered to scatter its seeds, it will come up and flourish without any care; and many times becomes a troublesome weed: this will thrive in the Smoak of London, so that it is a very proper plant to adorn the City Gardens."

An important record and an accurate (colored) plate of *Oenothera*, is found in Miller's Figures of plants in the Gardener's Dictionary, the editions of 1760 and 1771 being practically identical. The figures in this work appear to be all natural size. Plate 188 is of *O. pumila* and plate 189, which is dated 1757, contains two figures. It is quite clear that these are what we now know as *O. muricata* and *O. biennis*. Fig. 1 is cited as follows:

"Oenothera foliis lanceolatis dentatis, caule hispido."

Tree Primrose with Spear-shaped indented Leaves, and a prickly Stalk. This is the *Oenothera foliis lanceolatis capsulis acutangulis*, Lin. Sp. Plant. 346. Tree Primrose with Spear-shaped Leaves, and Capsules with acute Angles. Tournefort titles it, *Onagra angustifolia, caule rubro, flore minore*, Inst. R. H. 302. Narrow-leaved Tree Primrose with a red Stalk and a smaller Flower."

In describing Fig. 1 he says definitely that the style is shorter than the stamina, and this is clearly shown by the figure. As indicated by the synonymy, as well as shown by the figure, this is the *O. fruticosa* of Linn. Sp. Pl. Ed. 1, which I have already shown is the plant we now know as *O. muricata* L. The size of the flowers, as well as the other characters, clearly correspond to certain races of this species, though the stem leaves appear to have been rather broader than typical.

In describing Fig. 2, we have the following:—

"Oenothera foliis ovato-lanceolatis planis, Virid. Cliff. 33."

Tree Primrose with oval Spear-shaped plain Leaves. This is the *Oenothera foliis ovato—lanceolatis, denticulatis, floribus lateralibus in summo caulis*, Hort. Cliff. 144. Tree Primrose with oval Spear-shaped indented Leaves, and Flowers proceeding from the wings of the Leaves on the upper Part of the Stalk. Tournefort titles it, *Onagra latifolia*, Inst. R. H. 302. Broad-leaved Tree Primrose; and by Caspar Bauhin, *Lysimachia lutea corniculata*, Pin. 245. Yellow horned Loosestrife."

The accompanying passage is quoted in MacDougal (1907), p. 5. The characters shown in the figure make it evident that this plant was some race of what we now call *O. biennis*, L. This is shown by the size of the flowers and by the fact that the style is short so that the stamens surround the stigma. This figure would also, however, represent equally well certain hybrids between *O. biennis* and *O. Lamarckiana*. Miller in referring the plant to the species of Linnaeus already cited in the Hort. Cliff. did the natural thing, seeing that Linnaeus had not made a separate

species for forms with flowers of this size, although, as we have seen, the type of Linnaeus' species was clearly indicated by his citation of figures, both in the *Hort. Cliff.* and the *Species Plantarum*. In later works the large and small-flowered forms were usually referred indiscriminately to *O. biennis* L. Miller's citation of the synonymy of the *Hort. Cliff.* cannot, therefore, be taken as indicating that this plant referred to the type of Linnaeus' description, as this was evidently not the case.

Philip Miller was "gardener to the worshipful company of Apothecaries at their Botanic Garden at Chelsea." I have recently cultivated a race of *O. biennis* (as we now understand the name, i. e., a plant with smaller flowers than *O. Lamarckiana* and a short style so that the flower pollinates itself) received under that name from the Chelsea Physic Garden, whose flower characters agree in general with those of our *O. biennis*, but the rosette leaves and stem leaves are remarkably crinkled and in general appearance much resemble *O. Lamarckiana*, being quite unlike our *O. biennis* races. I mention this case not only to show that numerous races of *O. biennis* exist, differing widely from each other in certain features, but to emphasize the necessity, in determining any plant from the early records, of considering every character in so far as it can be known, before deciding upon its affinities.

Miller's statement that his plant is "more commonly seen in the Gardens than any of the other species" may be true, or it may indicate a failure to differentiate between this and the large-flowered forms. It seems probable, however, that the large-flowered forms had by this time largely disappeared from the English Gardens. We have seen that the large-flowered form referred to by Ray in 1686 which we have with a large degree of probability determined to be *O. grandiflora* from its eastern range in North America, was more common in gardens at that time than the other large-flowered form (*O. Lamarckiana*). Later, during the three-quarters of a century intervening between 1686 and 1760 both must have disappeared from cultivation in the English gardens.

It is interesting to note that *O. Simsiana* is a species with large flowers and a short style, so that the stigma is surrounded by the stamens, as in *O. biennis*. But this was not introduced into England until 1816 (see Curt. Bot. Mag. 45:1974), where it was raised in the garden of the Marquis of Bath at Longleats, in Wiltshire, from seeds obtained in Mexico. Moreover, its flowers are much larger than those in Miller's figure, and there are other differences. (See also Miss Vail's account in MacDougal, 1907, p. 68.)

From the use of the adjective *planis* in the polynomial cited by Linnaeus from *Vir. Cliff.* 33, it may be inferred that this plant did not have the crinkled character of the leaves as we know them in the present *O.*

Lamarckiana. The leaves in the upper part of the stem in *O. Lamarckiana*, are, however, frequently nearly or quite smooth.

We have shown that the first *Oenothera* introduced into Europe from Virginia was more closely related to the *O. Lamarckiana* of our present cultures than to any other form, differing from it only in such minor points as the width of the rosette leaves; which seem also to have been of a paler green color, because the Bauhin description and Parkinson agree on this point. But the important independent description of Hernandez in 1651 definitely refers to the crinkling of the leaves. This makes it highly probable that the plant of Hernandez was almost or quite identical with our *O. Lamarckiana*, Ser.

O. GRANDIFLORA AIT.

The history of the discovery of *O. grandiflora* in Alabama and its introduction into Kew has already been given by DeVries (1901) and particularly MacDougal (1905, p. 7), and need not be repeated here. But certain interesting data can be added. Before entering upon these it will be advantageous to outline some of the differences between *O. Lamarckiana* and *O. grandiflora* as we now know them from cultures (see Vail, 1907, p. 66; Gates, 1909c, p. 131). In *O. grandiflora* the buds bear only a short and inconspicuous type of hair, giving them an almost glabrous appearance (in some cases entirely glabrous), while in *O. Lamarckiana* and all its mutants there is in addition a long, curved type of hair, arising from papillae and giving the buds a pubescent appearance. The same is true of *O. biennis*. The same type of hair is found on the stems in *O. Lamarckiana* and *O. biennis*, arising from papillae which are usually red, so that the stem is covered with small red dots. *O. grandiflora* from Alabama shows the same condition on the stem, but in some of the forms of *O. grandiflora* from near Liverpool, England, the long type of hair is frequently almost wholly absent, leaving the stem nearly glabrous. The buds in *O. grandiflora* are also more slender and rounded, and the sepal tips frequently longer and usually more setaceous than in *O. Lamarckiana*.

In addition the rosettes are very unlike, the leaves in *O. grandiflora* being smooth, thin, and with a series of characteristic basal lobes, while in *O. Lamarckiana* they are crinkled, thicker, and without the basal lobes. But unfortunately, the rosettes are rarely mentioned, except in connection with recent studies and cultures, and in the very early works.

Professor DeVries has given an account of the history and synonymy of *O. grandiflora* Ait. He prefers to call it *O. suaveolens*, the name introduced by Desfontaines, to avoid confusion on account of the various

forms to which the name *O. grandiflora* has been applied.¹ The name was first given by William Aiton in *Hortus Kewensis*, Vol. II, p. 2, 1789, in which a figure by L'Heritier, *Stirpes Novae*, tom. 2, tab. 4, is cited. In the second edition of *Hortus Kewensis*, by W. T. Aiton (1811), the same brief description is given, Vol. II, p. 341, but instead of the L'Heritier plate, a description by Willdenow, *Species Plantarum*, Vol. II, p. 306 (1789), is cited. Britten and Woodward (1905) have traced the history of a number of plates of L'Heritier, which were intended for a second volume of the *Stirpes Novae* which was never published. Some of these plates are now in the DeCandolle library, some in Moretti's library and some in the library at Kew. Among them is the plate of *Oenothera grandiflora*, which is referred to in a letter to Dryander dated August 18, 1788. (See Britten and Woodward, l. c.) Through the kindness of M. Casimir De Candolle I have been able to obtain the original manuscript of L'Heritier, in which his description of *O. grandiflora* was prepared. M. DeCandolle very kindly forwarded from his library a manuscript of five pages, giving L'Heritier's original description of as many species of *Oenothera*. The plate (No. 4) of *O. grandiflora* was, however, not in the DeCandolle library, and if it is still in existence it will probably be found in the library at Kew.¹ I have reproduced here a photograph and transcription of this, chronologically the earliest, description of *O. grandiflora*, unless we call Ray's brief account (1686) a description. A number of points in the description make it certain that the plant described is *O. grandiflora* Ait., as we know it, and not *O. Lamarchiana*. I am greatly indebted to Professor Trelease for valuable aid in deciphering the manuscript and in tracing these records.

It is now possible to show clearly that there were at least two races of *O. grandiflora*. The first of these is represented by what I have called the Eastern *O. grandiflora*, originally wild in Carolina, Virginia and adjacent regions and well illustrated by Barton in *The Flora of North America* (Vol. 1, pl. 6), 1821. Certain *O. grandiflora* forms from my cultures of *Oenotheras* from parts of the coast near Liverpool, England, agree with this form in every respect, which seemingly substantiates my conclusion arrived at from the historical data, that the original introduction of *O. grandiflora* took place at a very early date, from Eastern North America, the English plants being descended from this form escaped from gardens at an early period.

¹See DeVries, *Mutation Theory*, 1909, Vol. I, p. 440 et seq. Also MacDougal et al. 1905, p. 7.

¹A subsequent examination of the plates of L'Heritier in the Kew Library, shows that the illustration of *O. grandiflora* is not among them.

The *O. grandiflora* which was introduced into Kew from Alabama in 1760 differs from the Eastern form in a number of minor, though constant, characters, as shown by cultures. Among these differences may be mentioned, (1) in the Eastern form, as figured by Barton and as shown in cultures from near St. Anne's, England, the stem leaves are much broader than in the present Alabama form of my cultures, though the leaves of both agree in being tapering and acute at both ends.¹ (2) The flowers in the Eastern form are fully as large as in *O. Lamarckiana*, the petals being broad and overlapping in the opened flower, as in *O. Lamarckiana*. In the Alabama form, on the other hand, the flowers (in my cultures) are considerably smaller and the petals are narrower and more cuneate, so that spaces occur between them in the expanded flower. (3) In bud characters, the "Eastern *grandiflora*," as determined from the English plants, bears on its sepals a short and inconspicuous type of hair, while the sepals of the Alabama *grandiflora* are entirely glabrous. (4) On the other hand, the stems of the Eastern *grandiflora* are frequently almost free from hairs either of the long or short type, while the Alabama form bears, especially on its branches, many of the long hairs arising from papillae.¹ (5) The "Eastern" plants average considerably larger than the Alabama ones. It is possible that some of these distinctions are due to environmental differences and are not permanently inherited.

Among the points in L'Heritier's description of *O. grandiflora* (which was evidently carefully written, using the *Genera Plantarum* as a model, though never published) which make it certain that it is this form and not *O. Lamarckiana* which is described, are the words "folia ovato-lanceolata, utrinque acuta," applied to the leaves of the stem. The term ovate-lanceolate has also been applied to the early descriptions of *O. Lamarckiana*, but the stem leaves of *O. Lamarckiana* are not so broad as those of some races of *O. biennis* and *O. grandiflora*. The stem leaves of *O. Lamarckiana* Ser., can not be described as acute at both ends, while this is perfectly true of *O. grandiflora*. The width of the stem leaves, however, given as 3 inches, is exceptionally broad. It is interesting to note that the cotyledons are described as deltoid-lanceolate. I have not observed the cotyledons of *O. grandiflora*, but I have observed them in a form whose bud characters and other features show its close relationship to *O. grandiflora*. These cotyledons become characteristically deltoid-lanceolate. This is true, though apparently to a lesser extent, of

¹The description of *O. grandiflora* by L'Heritier (q. v.) shows that his (Alabama) plants had very broad leaves. It is therefore probable that both the broad and narrow-leaved races occurred in both the Eastern and Southern range of the species.

²For other data regarding the types of hairs and their inheritance in certain *Oenotheras*, see Cannon (1909).

the *O. Lamarckiana* forms. It is a very transient condition in all.

Plate 5 is from a photograph of this page of manuscript. The following is the transcription. The characters of the manuscript were literally transcribed as far as they could be deciphered.

Conf. *Onagra latifolia* floribus amplis. Tourn. inst. 302.

Blaikie.

OENOTHERA GRANDIFLORA.

Cal. Perianthium monophyllum superum inferne tubulosum, apice 4-partitum pubescens. Tubus cylindricus longissimus intus canescens. Limbus quadripartitus dependens; laciniis lineari lanceolatis apice subulatis plerum una altera ve excepta sutis, tubo brevioribus, longit. 2 poll.

Cor. Petala 4. obcordata, argutissime denticulata, s. integra, laciniis calycinis longiora, ad apicem tubi inter divisures inserta, lineata.

Stam. filamenta 8. declinata, fauci calycis inserta, corolla breviora lutea. Antherae lineares biloculares, peltatae, longissime.

Pist. German inferum cylindricum, tetragonum, pubescens, longit. 5 lin. Stylus filiformis intra tubum pubescens extra deflexus, staminibus longior. Stigma maximum quadrellobum?, cruciforme; lobis crassis teretibus patentissimis glutinosis.

Per. Capsula cylindrica, demum subtetragona quadrinervis, quadrilocularis, quadrivalvis, apice primum dehiscens, subvillosa, sessilis, dissepimentis valvulae singulae

(oppositis

(contrariis

ejusdemque substantiae a columella subulata quadrangula discedentibus, longit. 15 lin. diam. 3 lin.

Sem. numerosa, obsolete angulata, columella affixa, fusca, parva.

Spica terminalis, prolifer, erecta, foliacea S. bracteata, pubescens pedalis flores sessiles, lutei, odoratissimi, longit 4. poll. diam. 3. poll. Bracteae lanceolatae, acutae, remote—dentatae, sessiles nisi ter minores in omnia foliis conformes.

Folia ovato—lanceolata, utrinque acuta laxe—dentata, nervosa supra viridia infra pallida pubescentia que, subsessilia alterna, subdependentia, longit, 4-5 poll. diam. 3. poll.

Caulis erectus uti fruticosus, ramosus, rimis corticem abjiciens, rami teretes villosi, scabri, ramuli patuli.

.Cotyledones deltoideo—lanceolati, obtusi, sessiles.

O. fol. ovato—lanceolatis, staminibus acclinatis, caule fruticoso.

All five pages of the L'Heritier MS were photographed, and prints together with transcriptions of each page were deposited in the herbarium of the Missouri Botanical Garden. The species described on the four other pages are as follows:

Oenothera paniculata. A line is drawn through the word *paniculata* and *fruticosa* L. is written above it. Evidently the writer finally decided that it was not a new species. Similarly, there is a description of *O. lyrata*, this being changed to *O. rosea*. Another page is devoted to a

description of an *Oenothera* which is said to be between *O. mollissima* and *O. sinuata*, but no name is given to it. The last page is a note on some *Onagra* from the Banks Herbarium.

It is important to note that Willdenow in his edition of Linnaeus' *Species Plantarum* (3:306) in 1799, to the polynomial description of *O. grandiflora*, *œ foliis ovato-lanceolatis, staminibus declinatis, caule fruticoso*, adds "*Caulis, folia et germina glabra*," which makes it evident that the long type of hair was almost wholly absent from the stems as well as the buds of these plants. This agrees with the characters of many plants in the *O. grandiflora* series from England, elsewhere described. They cannot have lost this type of hair through crosses with *O. Lamarckiana* or *O. biennis* forms, for the latter both have it. While not strictly glabrous, these plants of *O. grandiflora* are relatively so compared with *O. Lamarckiana* and *O. biennis*, and the older regions of the epidermis often become glabrous by the loss of the delicate type of hair as the epidermal cell walls become thicker.

In 1797 Lamarck, in his *Dictionnaire* (p. 554), described a new species *O. grandiflora*, evidently not knowing that this name had already been used by Aiton. (See DeVries 1895, 1901, 1909.) In this description of Lamarck (or rather Poiret; see DeVries 1909, p. 442), which was written only from herbarium material, and the name of which was changed by Seringe to *O. Lamarckiana*, there are several points which need to be carefully scrutinized because they refer to the differences between *O. Lamarckiana* and *O. grandiflora* as we now know them. In describing the calyx, the words "*termines par un filet court, setace*" are used, referring to the sepal tips. DeVries translates this clause (1901, p. 317) "*welche an der Spitze eine kurz, dicke, fadenfoermige Verlaengerung tragen*," and the English rendering of the German is "which are terminated by a short, fat, thread-like prolongation." The latter, while an equivalent of the German, is not correct when applied to the French. The difficulty is in DeVries' use of the word "*dicke*" apparently as an equivalent of the French "*setace*." This difference is referred to because in *O. Lamarckiana* and its derivatives, as we know it in cultures, the sepal tips are usually thicker than in *O. grandiflora*. The words used in the French description really apply better to *O. grandiflora* than to *O. Lamarckiana*, but in herbarium material they would probably apply equally well to *O. Lamarckiana*. The original description also uses the expression "*lisses et glabres des deux cotes*" in describing the stem leaves. This is of course not true of living material of *O. Lamarckiana*, except, that the upper stem-leaves (which are the ones usually preserved in an herbarium specimen) are usually nearly free from crinkling. De-

Vries, however (1909, p. 442), assures us that the original specimens from which the description was drawn agree exactly with the *O. Lamarckiana* used in his cultures, although he says that they by no means represent the mean type of the species in every respect.

De Candolle in the *Prodromus* (III:46) in 1828 segregates *O. grandiflora* Ait., *O. suaveolens* Desf., and *O. Lamarckiana* Ser. from *O. biennis* L. *O. suaveolens* is recognized as probably referable to *O. grandiflora* Ait., as DeVries has shown to be the case (1895 p. 587), under *O. biennis* L. are cited as figures *Fl. Danica* 3:pl. 446 (which seems to represent a race of the "European *biennis*") and Miller's *Gard. Dict.*, pl. 189, Fig. 2. which I have already referred to as probably a race of our present *O. biennis*, or perhaps a hybrid between *O. biennis* and *O. Lamarckiana*. The *O. Lamarckiana* of the Seringe Mss. as is well known, was the *O. grandiflora* of Lamarck's *Dictionnaire*. Under *O. grandiflora* Ait. DeCandolle cites Sims in *Curt. Bot. Mag.*, 46 pl. 2068 (1819), to which I may now refer.

Sims distinguishes a form (A) which he characterizes as "Caule, foliis, germinibusque glabris" and a form (B) "caule et germinibus, subpubescentibus, foliis calycibusque villosis." The plate refers to the (B) form. I formerly considered that this plate represented *O. Lamarckiana* rather than *O. grandiflora*, on account of the rather narrow leaves and the stout sepal tips. A direct comparison of the measurements of the plate with those of a culture of the Alabama *O. grandiflora* from seeds obtained from Prof. S. M. Tracy, makes it evident, however, that the two agree in practically all their characters and measurements, even in the rather narrowly cuneate petals with spaces between them. The last character is more conspicuous in flowers blooming late in the season. Regarding the difference between his two forms, Sims says, "Except in the slight pubescence of the stem, germen and tube of the calyx, and the soft villous leaves, our plant differs in no respect from *Oenothera grandiflora*, of which, therefore, it must be considered as a mere variety." He then says it is a native of Carolina. In cultures of *O. grandiflora* races from plants naturalized on the Lancashire coast of England, I have found differences similar to those between Sims' forms. Other series of races are found to exist, differing from each other less than the present *O. grandiflora* and *O. Lamarckiana* in the strict sense differ from each other. My recent cultures indicate that, however they may have originated, numbers of such races occur and breed true to their peculiarities. When self-pollinated they behave as "pure lines." What their behavior in crossing may be is as yet unknown.

We have seen that, previous to the introduction of *O. grandiflora* in 1788, a large-flowered form which was at any rate more closely similar to *O. Lamarckiana* than to any other species except perhaps *O. laevifolia*, had been commonly grown in European gardens and illustrated with various figures. This was the first *Oenothera* to be introduced from the New World, about 1614. Already in 1737 (Hort. Cliff.) it had escaped from gardens and was found growing wild in large numbers in Holland and (Hort. Upsal. 1748) was widely distributed in Europe. It is altogether probable that various races were included in this distribution, even at that time. I have not attempted to trace the earliest references to the occurrence of *Oenotheras* wild in England, but it was abundant on the coast near Liverpool in 1805, (Sowerby Eng. Bot., 22 pl. 1534) and probably existed there much earlier. Thompson (1905) states that 1837 is the first record of its occurrence wild on the coast of Somerset. He refers to the form as *O. biennis* L., but it has recently been shown by cultures to include *O. Lamarckiana* and other forms. For a summary of the distribution of *Oenotheras* in Europe see A. DeCandolle (1855) (II:710). They are naturalized and growing abundantly in many places.

The Liverpool plants now consist of *O. Lamarckiana* and certain of its mutants, as well as *O. grandiflora* and a great variety of hybrids between these forms. Perhaps it would be equally correct to regard them as a series of intermingling "pure" lines or races. The *O. Lamarckiana* is certainly very closely similar to that of DeVries' cultures, but there seem native to Virginia would belong to a different elementary species from that in Texas.

In 1832 Don (2:685), under the name *O. biennis* refers to *Oenotheras* growing in the greatest abundance on the Lancashire coast, north of Liverpool, and also says, "It covers several acres of ground near Woodbridge, Suffolk." The flowers are referred to as "large, pale yellow, and delicately fragrant." In Edwards' Botanical Register (19. pl. 1604) in 1833, a large-flowered form is figured under the name *Oenothera biennis* var. *grandiflora* by Lindley. The flowers and the flowering shoot probably represent *O. Lamarckiana*, for though the shoot is slender and with only slight pubescence, yet the flower buds are rather stout and with short sepal tips as represented, though scarcely decisive. But the leaf (which probably is from the rosette or far down on the stem) is much longer and more narrowly lanceolate than shown by *O. grandiflora*. This leaf is very narrow even for *O. Lamarckiana*, but the sessile stem leaves with their broad clasping bases, certainly characterize *O. Lamarckiana* rather than *O. grandiflora*.

Baxter in his *British Phanerogamous Botany*, in 1839, gives a plate (4:257) which seems to resemble *O. Lamarckiana* rather than *O. grandiflora*. But doubtless *O. grandiflora* from its first introduction from Virginia (?) had escaped from English gardens long before the later introduction in 1778, and was growing wild as we now find it, mingled with *O. Lamarckiana* forms. This figure may therefore refer to some hybrid between the two.¹ It is referred to as *O. biennis*, the only English species.

Dietrich, in characterizing *O. grandiflora* Ait. in the German flora (*Gaertneri und Botanik* 6:202) in 1837, describes the leaves as smooth and the capsules as "filzig." The style is described as "so lang als die Staubfaeden." The hairiness of the capsule and especially the short style make it not improbable that he was describing hybrids between *O. biennis* and *O. grandiflora*.

After the time of Linnaeus, the large-flowered *Oenotheras* are frequently referred to and figured as *O. biennis*, and in England this practice has continued down to the present time. It is justified, as we have seen, by Linnaeus' citation of figures in his characterization of the species. But in America, where these large-flowered species have long been rare or absent, usage has tended to confine the term to a small-flowered self-pollinating form, and this is what is meant when the name *O. biennis* L. is used in the present paper. Thus a plant is figured under this name by Sowerby (*English Botany* 22 pl. 1534) in 1806, and he says "Our specimen was gathered on the extensive and dreary sand-banks on the coast a few miles north of Liverpool, where millions of the same species have been observed . . . perfectly wild, and covering a large tract between the first and second range of sand-hills." The plate has large flowers and answers to *O. Lamarckiana* rather than to *O. grandiflora* (See plate 6). However, at this date *O. grandiflora* was also doubtless naturalized in the same locality, where my cultures have shown that the two species are intercrossing freely, and the plant figured in Sowerby undoubtedly represents one of many such races growing together in that locality. As already mentioned, some *O. grandiflora*

¹I should point out that treating such intermediate races as possible hybrids does not in the least explain their origin from an evolutionary standpoint. Just as there is no such thing in nature as a sharply defined Linnaean "species," but rather a host of more or less independent elementary species which, in open-pollinated forms, are continually intercrossing so that the lines of descent are changing with each generation; so there is no sharp line between a hybrid and a pure form. By self pollinating during successive generations, the individuals will be found to breed true to smaller and smaller differences, except when mutations occur. If such "pure" individuals are then pollinated from some other race, no one can say how closely or distantly that race should be related to produce a hybrid rather than a "pure" strain. In nature, except in strictly self-fertilized forms, the indiscriminate crossing of individuals exhibiting a host of minute character differences, is the normal condition. The process of separating and purifying races by self-pollination is analogous to the chemical process of fractional crystallization.

flora forms are almost wholly lacking in the long type of hair. It may be said that the hybrids between *O. Lamarckiana* and these *O. grandiflora* forms, usually at least possess the papillae on the stem which are characteristic of *O. Lamarckiana*, but their stems and buds are less hairy, the long type of hair being present but much less numerous than in *O. Lamarckiana*. The rather smoothish aspect of the stem and buds in the plant figured lead one to believe that it was probably a hybrid between *O. Lamarckiana* and one of these *O. grandiflora* forms. My cultures of *Oenotheras* from this region show certain races, having similar characters. It is probable that some races of *O. grandiflora* in its eastern range differed from the present *O. grandiflora* in Alabama, in having a very few of the long type of hair.

I regard these plants of *O. Lamarckiana* and *O. grandiflora* now flourishing on the English coast, as most probably derived from escapes from the English Gardens, such escapes having probably taken place early in the seventeenth century, from the plants introduced from "Virginia" about 1614. *O. Lamarckiana* is known to have been abundant on the English coast as early as 1805, long before its (second) introduction into Kew in 1860. Among the *Oenotheras* at St. Anne's I could find no small-flowered forms, so that *O. Lamarckiana* could not have originated here from a cross between *O. grandiflora* and *O. biennis* races. Neither is there any probability that *O. biennis* has occurred here formerly and has since died out, for the self-pollinating forms invariably set more sets than the open-pollinating, and thus have a better chance to multiply in the struggle for existence.

It will therefore be possible to compare this—the "Virginian *Lamarckiana*"—with the "Texas *Lamarckiana*" which formed the basis of De Vries cultures, if my hypothesis regarding the origin of the English plants is correct.

After *O. Lamarckiana* was introduced from Texas in 1860 it was figured in the *Floral Magazine* (2 pl. 78) in 1862 and copied by Lemaire in the *Illustration Horticole* (9 pl. 318) in the same year. As already stated, this was the source of the *O. Lamarckiana* of DeVries' cultures.

To return to the history of *O. grandiflora* Ait. there seems to be good evidence that this species was taken to Europe from its Eastern range in Carolina, Georgia, and the adjacent region, at least as early as 1669, i. e., long previous to its introduction into Kew from Alabama in 1778. Since that early introduction it has escaped from botanical gardens, just as did *O. Lamarckiana*, and is now growing wild in various parts of Europe. It is found abundantly in western France (Gillot, cited by DeVries, 1909, p. 443) and in other parts of the continent.

DeVries (1909 p. 441 footnote), in discussing *O. grandiflora*, says, "My investigations in the herbarium at Paris have convinced me of the identity of the form I cultivate as *O. suaveolens* Desf. (*O. macrantha* Hort.) with the form described by Desfontaines. Both of them have flowers of the same size as those of *O. biennis*." This is explained by the fact that the European *O. biennis* has larger flowers than the American races, though smaller than *O. Lamarckiana*, while the Alabama *O. grandiflora* has flowers which are also, in some cases, distinctly smaller than in *O. Lamarckiana*.

From the fact that the *Oenotheras* established on the sand dunes of the English coast north of Liverpool include *O. Lamarckiana* and *O. grandiflora*, where they have freely multiplied and intercrossed since at least 1805, and probably much earlier, the conclusion is scarcely avoidable that this *O. Lamarckiana* must have been derived from the early introduction of these plants from Virginia, for the Texas plant was not introduced until 1860.

At one stage in the progress of these historical investigations I thought it probable that *O. grandiflora* had been introduced into this English locality much later, i. e., since the introduction of this plant from Alabama in 1778. It seems improbable, however, that both *O. Lamarckiana* and *O. biennis* would be taken over from Virginia, and *O. grandiflora* remain behind. As already stated, I believe that Ray's species number 11 belongs to *O. grandiflora*. It seems not improbable that the absence of later recognition of two large-flowered forms may have been due to subsequent crossing in gardens, which is very likely to have occurred and which (as I have found from my cultures) would tend to obscure the distinctions between the two species, by creating intermediates. For instance, the statements of Lindley in Edwards' Bot. Register 19 pl. 1604. (1833) in which the figure of a plant which is most like *O. Lamarckiana* Ser. is given under the name *O. biennis* var. *grandiflora*, show that very probably the limits between *O. biennis* L., *O. Lamarckiana* Ser. and *O. grandiflora* Ait. had been largely obscured and eliminated by spontaneous crossing in gardens during the long period of their cultivation.

Miller, in the Gardener's Dictionary, in 1807 (Vol. 2 Part 1) cites under *Oenothera*, *O. biennis*, *O. grandiflora*, *O. parviflora*, *O. muricata*, *O. longiflora*, *O. fruticosa*, and others. The plant referred to under *O. biennis* is described in part as follows: "Germ sessile, an inch long or more; on the top of this is the tube of the calyx, from an inch to almost two inches in length, and narrow, spreading out at the top into four acute segments, villose on the outside, an inch in length, bent down by

pairs when the corolla expands and then rolled inwards." The corolla is described as one and a half to nearly two inches in diameter.

From this description and the careful measurements it is evident that this plant had small flowers about the size of the American *O. biennis*. The synonymy and other statements, which were copied from book to book, cannot be taken as meaning anything in the present connection. Contemporaneously (1806) Sowerby, as we have seen, pictures a large-flowered form closely resembling *O. Lamarckiana*, under the name *O. biennis*, so that it is quite evident that at this time no distinction was drawn between *O. biennis* and *O. Lamarckiana* forms, although *O. grandiflora* had been segregated.

The condition of the plants now growing wild and freely intercrossing on the sand-dunes near Liverpool, is probably somewhat similar to what it was in their original home in Virginia, although it is probable that in their original habitat the individuals were much more scattered, owing to the nature of the habitat and the competition of other plants. For this reason, crosses between the different species were much less likely to occur, but that such crosses did occasionally occur there can be no doubt. It seems characteristic of species which have become "weeds" in another country, that they grow in large numbers of individuals closely aggregated in localized areas, while in their native habitat they are more uniformly scattered over larger areas, taking their part in the regular flora of the country. The reasons for this difference in distribution I shall not discuss here. In the case of the open-pollinated Evening Primroses, it is not at all improbable and indeed may be regarded as certain, that crosses between different forms did occasionally occur where their ranges of distribution overlapped. In the case of the three species we are considering here, it is probable that before the white man's invasion of the continent, all three were to be found over a large part of the country. Since then the small-flowered, close-pollinated *O. biennis* and its related forms, such as *O. Oakesiana*, *O. muricata* and *O. fruticosa*, have continued to maintain themselves, while the open-pollinated *O. grandiflora* seems to have nearly or quite disappeared from its Eastern range in Virginia and Carolina, and *O. Lamarckiana* seems to have become quite extinct on this continent.

It would seem, therefore, that the close-pollinated species have been more successful in their competition with the conditions introduced by civilization, than the open-pollinated forms. This might be expected, because in close-pollinated forms seed production is always certain to follow flowering, while in open-pollinated species, with increased enemies

and lessening numbers, the amount of seed-production may fall below the minimum necessary for the perpetuation of the species.

Dr. W. O. Focke, of Bremen, first identified the *Oenotheras* near Liverpool, England, as belonging to *O. Lamarckiana*. Charles Bailey, in a more recent account of this vegetation (1907a, b) concludes that their introduction probably came from sweepings of grain-ships and docks and in grain for poultry from America. It seems more probable, however, that they originated as escapes from English gardens at a very early date.

In concluding this examination of historical records it should be said that I have endeavoured to present the documents and other evidence from which my inferences and conclusions have been drawn, in such a way that the reader who examines the evidence can judge for himself of the justice of the conclusions deduced. I have not been biased in favor of any theory of the origin and history of *O. Lamarckiana*. I have shown that a form very closely resembling *O. Lamarckiana*, except in certain rosette characters, was originally wild in Virginia, but it has never seemed to me that the question whether *O. Lamarckiana* has been hybridized or not is of great significance in connection with the interpretation of the mutation phenomena in these open pollinated forms, which must have experienced crossing in nature before their introduction into gardens. It is, however, a matter of much importance to determine that a form at least closely similar to *O. Lamarckiana* was the first *Oenothera* introduced into cultivation.

In nature, the individuals of all open-pollinated species are hybrids, in the sense that many more or less diverse elements have contributed to their ancestry. In making cultures from wild open-pollinated forms I have been impressed with the variability of the first generation in cultivation in comparison with forms which have been selfed for a number of generations. It is of course necessary, in breeding, to select certain individuals for later generations, and if these are self-pollinated the resulting races are sure to show increasing uniformity in later generations. If space for cultures permitted that every individual could thus become the starting point for a race, it would be found that each such individual would originate a race showing slight peculiarities. In the last analysis, as Jennings¹ has remarked, the differences between races would be found to go down to the limits of observation and measurement. The occasional appearance of mutants, or marked departures from the type which breed true, is of course another matter.

¹Jennings, H. S. Experimental evidence on the effectiveness of selection. Amer. Nat. 44: 136-145. 1910.

It may be pointed out that the mutants of *O. Lamarckiana* all have certain features in common, which they also share with the parent form. These (See Gates 1909) include (1) the presence of the long type of hair on the stems and buds, arising from papillae which, on the stems, are red; (2) the quadrangular shape of the buds; (3) the large flowers with long style. It has sometimes been suggested that the phenomenon of mutation in *O. Lamarckiana* is a form of hybrid splitting, *O. Lamarckiana* itself being merely a synthesized hybrid. Supposing this were the case, *O. grandiflora* and *O. biennis* are the only forms we know which could reasonably be assumed to have been its parents. It is true that *O. biennis* possesses the first two of the characters mentioned above, in common with *O. Lamarckiana* and its mutants. But if *O. Lamarckiana* had been synthesized in this manner, why should all the mutants fail entirely to show either the small flowers with short style, characteristic of *O. biennis*, or any of the many peculiarities (elsewhere enumerated) of *O. grandiflora*? All the evidence I can find, from every standpoint, is opposed to such a possible origin for the mutating *O. Lamarckiana*.

SUMMARY.

To recapitulate briefly the history of the three species *Oenothera Lamarckiana* Ser., *O. grandiflora* Ait., and *O. biennis* L., as far as it is now known, we may say that the form known to Bauhin in 1623 as *Lysimachia lutea corniculata* (*Onagra latifolia*, Tournefort, 1700) was a large-flowered *Oenothera*, undoubtedly more like *O. Lamarckiana* than any other species, though differing in certain rosette characters from the *O. Lamarckiana* of our present cultures. This is proved by an appendix in Bauhin's *Pinax*, and the original discovery of the record was from marginal notes copied into the book by Joannis Snippendale.

The important fact is thus disclosed that a form closely resembling *O. Lamarckiana* was the first *Oenothera* introduced into Europe from Virginia about 1614, and therefore that it did not originate in cultivation. While the *Oenothera* of this early record seems to have differed somewhat from our present *O. Lamarckiana*, these differences are small compared with the important characters in which they agree, and make it necessary to include this plant in the *O. Lamarckiana* series of forms.

This description by Bauhin, of plants grown in 1619, is evidently the basis of Robert Morison's description of the same plant in 1680. An independent description in Parkinson's *Paradisus* in 1629, refers to the same plant under the name *Lysimachia Virginiana*. Ray in 1686 in his *Historia Plantarum*, repeats the Morison description with numerous

changes and additions. Under the name *Lysimachia Americana*, Hernandez in 1651 gave an independent description of plants from Virginia, (*O. Lamarckiana*?) in which the characteristic crinkling of the leaves is definitely described. These records are all of prime importance, and the full text of the descriptions is given in each case.

The recognition of large- and small-flowered forms in published works came in 1669 by Morison. When *O. biennis* was first introduced is not determined, but Barrelier (1714) gives three figures, the first of which is probably *O. Lamarckiana* Ser., but may be *O. grandiflora* Ait., the second is *O. biennis* L. and the third *O. muricata* L. (See plates 3 and 4).

The earliest figure of an *Oenothera* was in Alpin's *De Plantis Exoticis*, 1627, where an evening primrose from Virginia is drawn, under the name *Hyoscyamus Virginianus*. (See plate 1). The seeds were obtained from an English physician, Dr. More, and the plant is very probably the same as Bauhin's *Lysimachia lutea corniculata*.

The races of *O. grandiflora* which I have been cultivating from near Liverpool, England, have in many cases much broader leaves than the *O. grandiflora* in my cultures from Alabama. It seems very probable that Ray's species 11 in 1686 was *O. grandiflora* Ait. introduced from its Eastern range in "Virginia." This was the commonest form in the English Gardens in Ray's time, and it is very probable that the *O. grandiflora* plants which were flourishing in a wild state on the English coast above Liverpool, and in Suffolk and elsewhere, as early as 1805 and probably much earlier were, like those of *O. Lamarckiana*, derived from very early garden escapes. I therefore consider it probable that *O. grandiflora* in its eastern American range had, in part at least, broader leaves than the Alabama form, though both types may have occurred in both regions. Some of the races from Liverpool also have considerably larger flowers with much longer hypanthia than our present *O. Lamarckiana*. From these facts it seems very probable that both *O. grandiflora* and *O. Lamarckiana* were twice introduced into cultivation, these forms having passed out of cultivation and become naturalized in many localities in England and elsewhere, during the long interval of about a century in the former case and nearly two centuries in the latter, between the first and second introductions.

Linnaeus, in his *Species Plantarum*, cites in the synonymy, as the type of his species *O. biennis*, Morison's figure of *Lysimachia Virginiana latifolia, lutea, corniculata*, which is the same plant as Bauhin's *Lysimachia lutea corniculata*, and which comes in the *O. Lamarckiana* series of forms, having large flowers and quadrangular buds. Linnaeus also cites the *Hortus Cliffortianus* in his synonymy, in which is cited

Barrelier's figure of *Lysimachia lutea corniculata latifolia lusitanica* together with the figure of Morison's already referred to. It is very probable that Barrelier's plant was the same as Morison's. The names used are almost identical but Barrelier cites as a synonym for his plant Tournefort's *Onagra latifolia, floribus amplis*. The latter is very probably our present *O. grandiflora* Ait. Linnaeus in the *Hort. Cliff.* evidently concludes that Morison's and Barrelier's plants are the same, and segregates *Onagra latiflora, floribus amplis* as a subform. Therefore the type of Linnaeus' *O. biennis* was a large-flowered form in the *O. Lamarckiana* series and may perhaps, have also included a form in the *O. grandiflora* series, if Barrelier was correct in his synonymy. But all the figures and names of small-flowered forms were definitely excluded, or rather ignored by Linnaeus.

After Linnaeus' time the small-flowered forms were included indiscriminately with the large-flowered ones under *O. biennis* L. The large-flowered forms later came to be designated *O. biennis* var. *grandiflora* until after the recognition again of *O. grandiflora* Ait. and *O. Lamarckiana* Ser. as separate species. Since then the name *O. biennis* L. has been chiefly confined to the small-flowered forms, although Linnaeus evidently intended as the type of his species the large-flowered forms. We know now that the difference between large and small-flowered species in *Oenothera* is an important one, involving various other changes in flower parts and connected with the habit of open or close pollination.

Ray described two large-flowered species in 1686. One of these was probably *O. Lamarckiana* and the other *O. grandiflora*, from its Eastern range in Carolina and Georgia. This is described as having broader leaves and much larger flowers.

In 1778 *O. grandiflora* Ait. was introduced into England after its discovery in Alabama by Bartram. It was described by Aiton, Willdenow, and by L'Heritier whose description (the most accurate) was never published, until reproduced here. Poiret described a plant in Lamarck's *Dictionnaire* in 1796 under the name *O. grandiflora*. This was recognized by Seringe to be different from the *O. grandiflora* of Aiton and Willdenow, and was named by him *O. Lamarckiana*. In this way was segregated a form which had long been going under the name *O. biennis* L. These now well-known facts have been brought together by DeVries and MacDougal.

In 1860 *O. Lamarckiana* Ser. was reintroduced into England from Texas. Seeds were distributed on the continent and this DeVries has shown to be the probable source of the *O. Lamarckiana* now grown in European gardens, and the source of his cultures. It is not impossible

that this *O. Lamarckiana* is different from the form whose history we have tried to trace, and which we believe was originally a native of Virginia; but the *O. Lamarckiana* now growing wild on the coast north of Liverpool, England, and which must have come from the early introduction (according to records which show that it has been growing abundantly there since at least 1805) is found from cultures to be very closely similar to the Texas form from which originated the plant in DeVries' cultures. *O. grandiflora* Ait. has also been shown, from statements of Bailey, and my own cultures, to be growing wild in the same English locality, and intercrossing freely with *O. Lamarckiana* and certain of its mutants. It seems probable that both species have been naturalized here since early in the 18th century.

The fact that the small-flowered forms are self-pollinating, gives them a much better chance in the struggle for existence than the large-flowered open-pollinating species because they have a better opportunity to set seeds. This probably accounts for the fact that the small-flowered forms are now more wide-spread and prevalent in Europe except in locations sparsely covered with vegetation, such as sand dunes, where the open-pollinated forms can aggregate in large numbers. It also probably explains the more or less complete disappearance of the large-flowered forms from eastern North America, since the introduction of civilization, for with increasing enemies the amount of seed production may fall below the minimum necessary for the preservation of the species.

Missouri Botanical Garden.

LIST OF HISTORICAL WORKS CONSULTED.

1623. Bauhin, Caspar. *Pinax Theatri Botanici*. Basil.
1627. Alpin, Prosper. *De Plantis Exoticis*. Venice.
1629. Parkinson, John. *Paradisus Terrestris*. London.
1640. Parkinson, John. *Theatrum Botanicum*. London.
1651. Hernandez, Francisco. *Rerum Medicarum Novae Hispaniae Thesaurus*. Rome.
1651. Hernandez, Francisco. *Nova Plantarum, Animalium et Mineralium Mexicanorum*. Rome.
1651. Bauhin, John. *Historia Plantarum Universalis*. Vol. II. Ebroduni.
1665. Jonquet, Dionysius. *Hortus Regius Parisiensis*.
1669. Morison, Robert. *Hortus Regius Blesensis*. London.
1677. Hoffman, Flora Altdorffina.
1680. Morison, Robert. *Plantarum Historiae Universalis Oxoniensis*. Oxford.
1686. Ray, John. *Historia Plantarum*. London.
1687. Hermannus, Paulus. *Horti Academici Lugduno-Batavi Catalogus*. Leyden.

1693. Plumier, Charles. Description des plantes de l'Amerique. Paris. Another edition, 1713.
1700. Tournefort, Joseph Pitton. Institutiones Rei Herbariae. Vol. I. Paris.
1714. Barrelier, Jacob. Plantae per Galliam, Hispaniam et Italiam observatae. Paris.
1737. Linnaeus, Carolus. Hortus Cliffortianus. Amsterdam.
1748. Linnaeus, Carolus. Hortus Upsaliensis. Stockholm.
1752. Miller, Philip. Gardener's Dictionary. 6th Edition. London.
1753. Linnaeus, Carolus. Species Plantarum. Holmiae.
- 1755-60. Plumier, Charles. Plantarum Americanarum. Amsterdam.
1756. Browne, Patrick. Civil and Natural History of Jamaica. London.
1760. Miller, Philip. Figures of Plants described in the Gardener's Dictionary. Other editions in 1771 and 1807. London.
1788. Jacquin, N. T. Selectarum Stirpium Americanarum Historia. Manhemii.
1789. Aiton, William. Hortus Kewensis. Vol. II. London.
1797. Lamarck. Encyclopedie Methodique. Botanique. Vol. IV. Paris.
1799. Willdenow, C. L. Species Plantarum. Vol. II. Berlin.
1806. Smith. English Botany. Vol. XXII.
1811. Aiton, W. T. Species Plantarum. 2d Edition, Vol. II. London.
1819. Curtis. Botanical Magazine. Vol. 46.
1821. Barton, W. P. C. A flora of North America. Philadelphia.
1828. De Candolle, Pyramus. Prodrum. Vol. III. Paris.
1832. Don, George. A general history of the dichlamydeous plants, etc.
1833. Edwards. Botanical Register. Vol. XIX.
1837. Dietrich. Gaertneri und Botanik. Vol. VI.
1839. Baxter. British Phanerogamous Botany. Vol. IV.
1855. DeCandolle, Alphonse. Geographie Botanique raisonnee. Paris.
1862. Dombrain, Rev. H. H. Floral Magazine. Vol. II.
1862. Lemaire. L'Illustration Horticole. Vol. IX.
1895. DeVries, Hugo. Sur l'introduction de l'*Oenothera Lamarckiana* dans le Pays-Bas. Nederland. Kruidk. Archief. 6:579-593.
- 1901-3. DeVries, Hugo. Die Mutationstheorie. Leipzig.
1903. MacDougal, D. T. Mutation in Plants. Amer. Nat. 37:737-770.
1905. DeVries, Hugo. Ueber die Dauer der Mutationsperiode bei *Oenothera Lamarckiana*. Ber. Deutsch. Bot. Gesells. 23:382-387.
1905. Thompson, H. Stuart. Coast *Oenotheras*. Journ. Bot. 43:62.
1905. Britten, James and Woodward, B. B. L'Heritier's Botanical Works. Journ. Bot. 43:266-273, 325-329.
1905. MacDougal, D. T. Assisted by A. M. Vail, G. H. Shull and J. K. Small. Mutants and hybrids of the *Oenotheras*. Carnegie Pub. No. 24. pp. 57. pls. 22. Washington.
1907. Bailey, Charles. De Lamarck's Evening Primrose on the sand-hills of St. Anne's-on-the-Sea, North Lancashire. Annual Address, Manchester Field Club, pp. 28, pls. 6.
1907. Bailey, Charles. Further notes on the adventitious vegetation of the sand-hills of St. Anne's-on-the-Sea. Mem. & Proc. Manchester Lit. & Phil. Soc. 51: No. 11, pp. 16, pls. 8.
1907. MacDougal, D. T., Vail, A. M., and Shull, G. H. Mutations, variations, and relationships of the *Oenotheras*. Carnegie Pub. No. 81, pp. 92, pls. 22.

1909. Cannon, W. A. Studies in heredity as illustrated by the trichomes of species and hybrids of *Juglans*, *Oenothera*, *Papaver* and *Solanum*. Carnegie Institution Pub. No. 117. pp. 67, figs. 20, pls. 10.

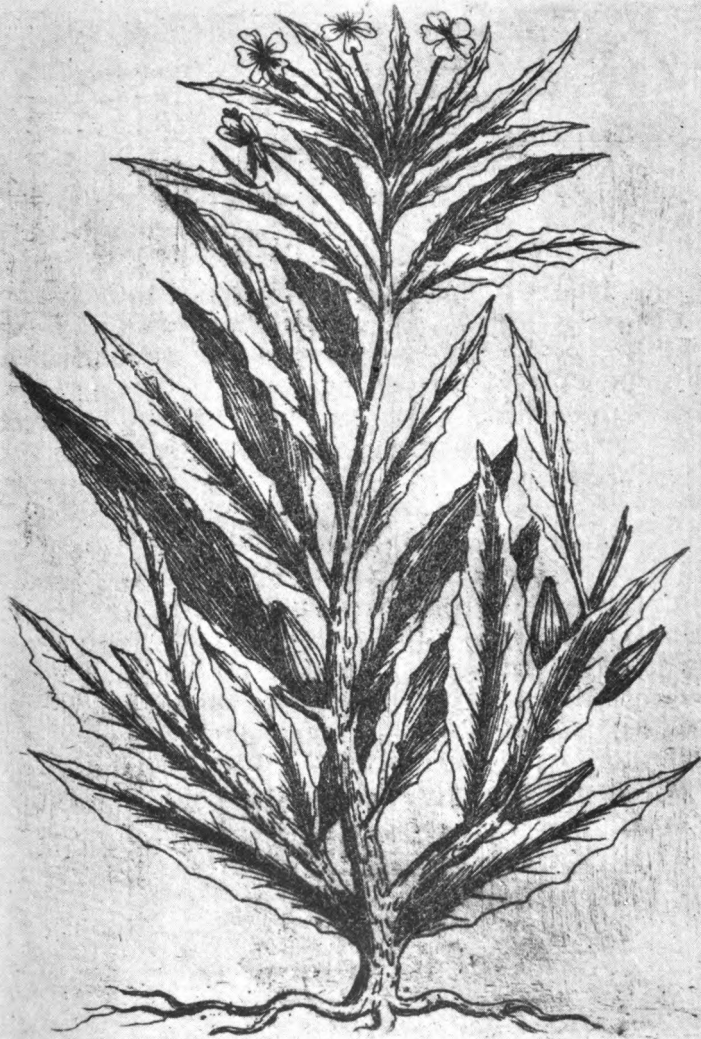
1909. DeVries, Hugo. *The Mutation Theorie*. Translated by J. D. Farmer. and A. D. Darbishire. Vol. I. Chicago.

1909. Gates, R. R. An analytical key to some of the segregates of *Oenothera*. Twentieth Annual Report, Mo. Botanical Garden: 123-137.

1910. Andrews, F. M. The botanical garden of the University of Amsterdam. *Plant World* 13:53-56.

1910. Gates, R. R. The earliest description of *Oenothera Lamarckiana*. *Science* N. s. 31:425-426.

Hyosciamus Virginianus.



Scrophularia berberis

Ab hinc

PLATE I.

Hyoscyamus Virginianus. Alpin's *De Pl. Exoticis*, p. 324.

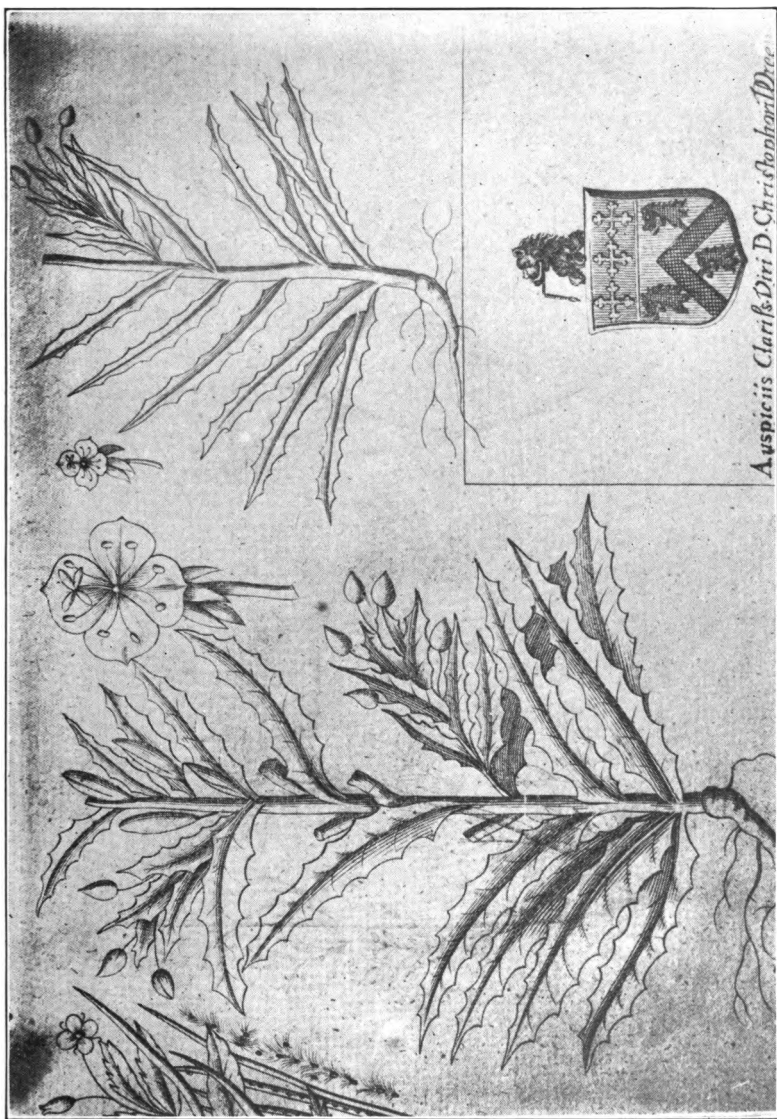


PLATE II.

Morison. *Hist. Pl. Univ. Oxon.* Sect. 3, tab. 11.

Fig. 7. *Lysimachia Virginiana latifolia, lutea, corniculata, nobis.*

Fig. 8. *Lysimachia Virginiana, angustifolia, corniculata, nobis.*

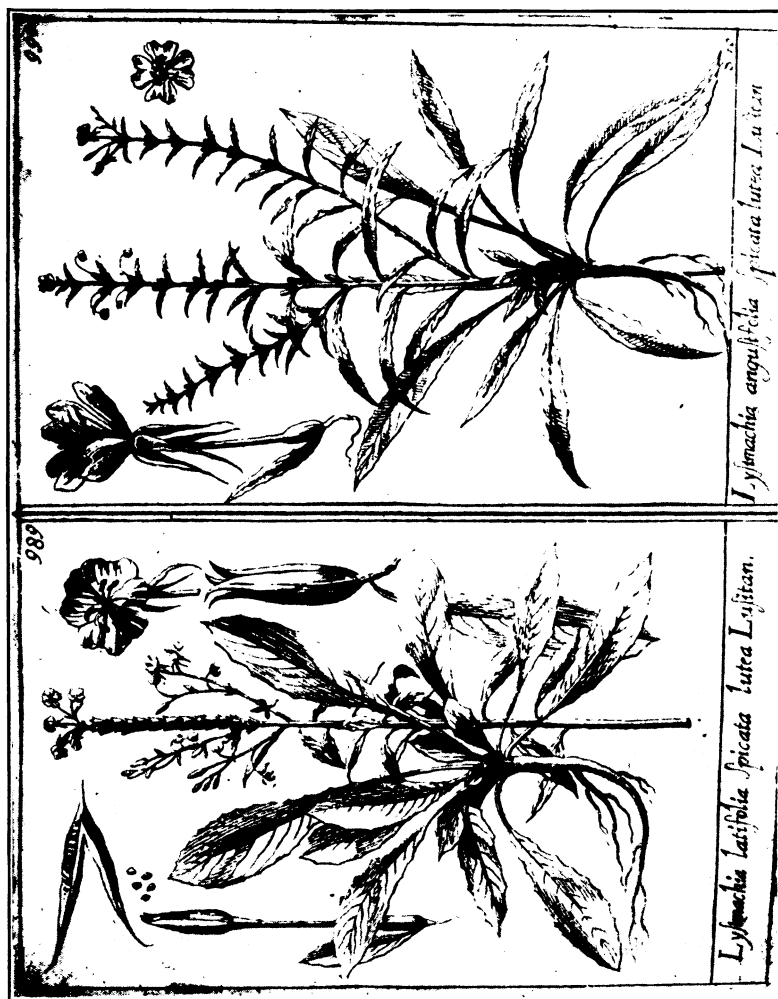


PLATE III.

Barrelier, *Plantae per Galliam, Hisp. et Italiane observatae.*

Fig. 989. *O. biennis*.

Fig. 990. *O. muricata*.

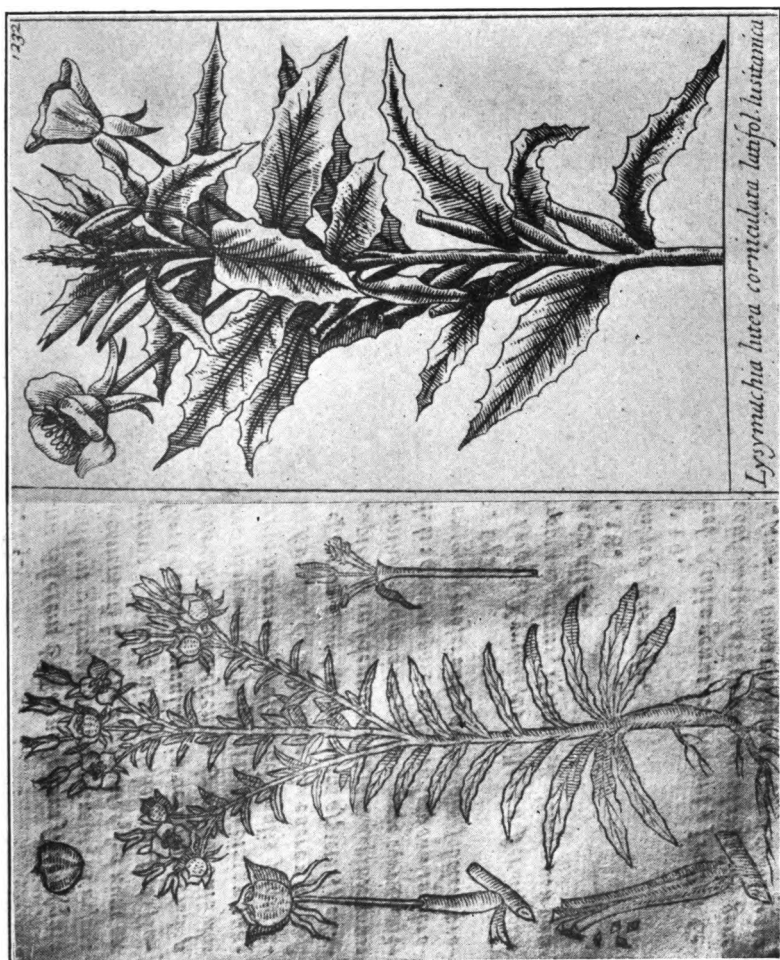


PLATE IV.

Lysimachia Americana.

Hernandez, *Nova. Plant. Annum. et Miner. Mex.*, p. 882.

O. Lamarckiana?

Fig. 1232. Borreller, *Plantae per Galliam, Hisp. et Italiam observatoe.*

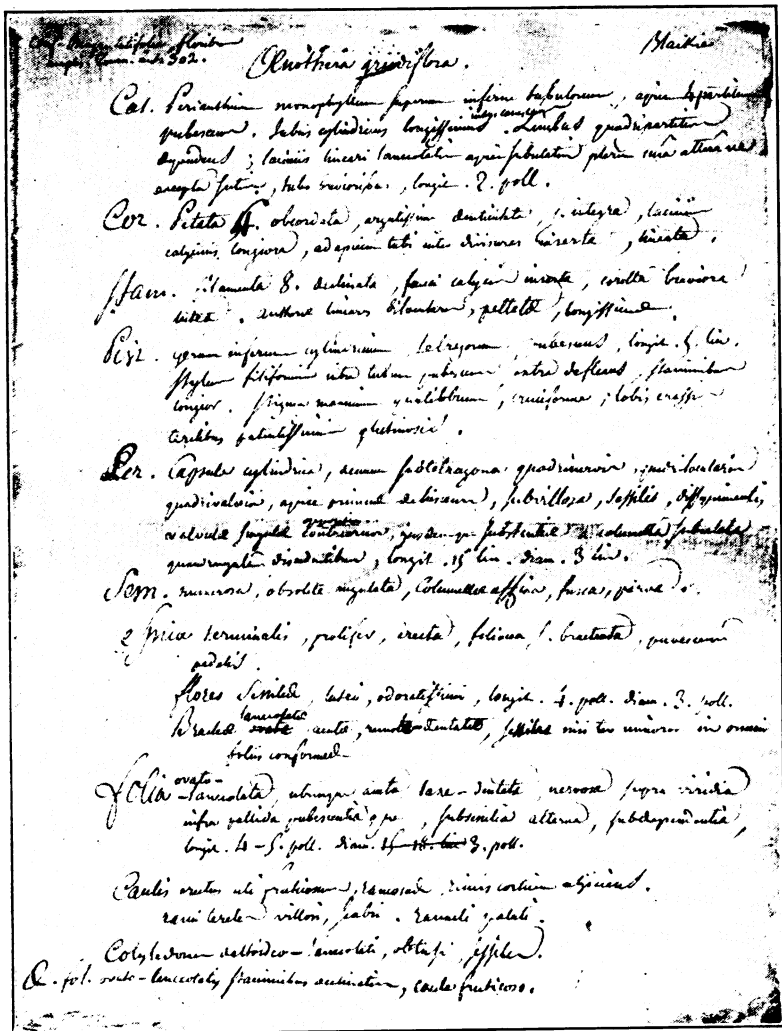


PLATE V.

L'Heritier MS. description of *O. grandiflora* Aiton.
(Published through the courtesy of M. Casimir DeCandolle.)

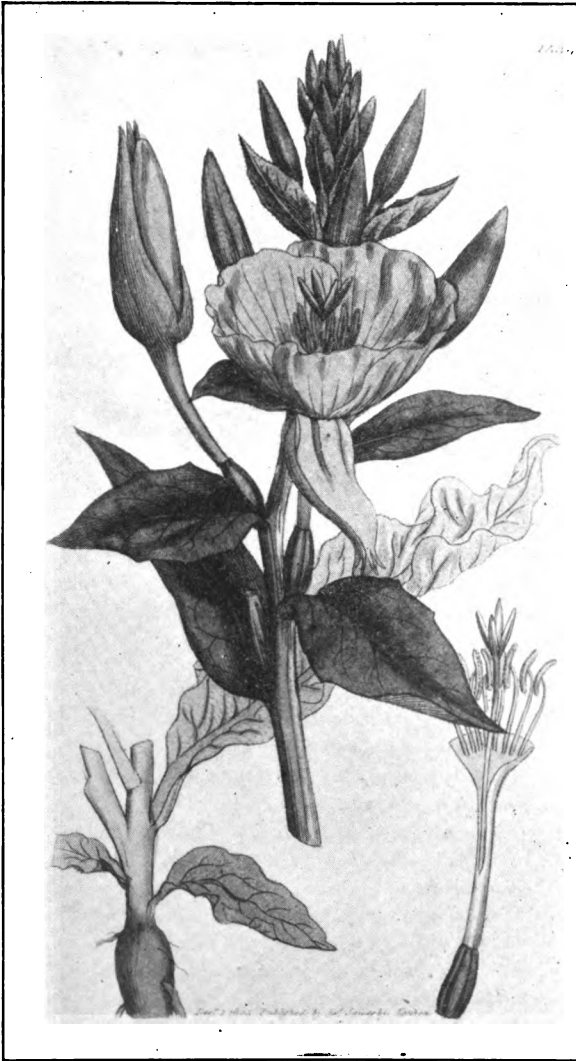


PLATE VI.

Oenothera biennis.

Sowerby's English Botany, Vol. 22, pl. 1534. 1806.

THE DIGESTIBILITY OF BLEACHED FLOUR.

BY ELBERT W. ROCKWOOD.

For several years the effects of the bleaching process upon the properties of wheat flour have been under discussion. The extent to which flour is used as a food material demands that in justice towards the consumers through tests should be made to determine whether the process is deleterious or not. In this paper no consideration will be given to any aspect of the case except that of digestibility.

Although at times a number of means have been employed to remove the natural yellow coloring matter from flour, and although several oxidizing agents will accomplish this result, at the present time the agent used in the great majority of mills is nitrogen peroxid. This may be generated from nitric acid but is usually produced by passing a current of air through an electric arc, when the nitrogen is oxidized by the oxygen to nitrogen peroxid. The flour is passed through a mixture of this gas with a large excess of air, being agitated meanwhile. The yellow color is immediately destroyed.

When nitrogen peroxid comes in contact with water a mixture of nitrous and nitric acids is formed. In the bleached flour there remains a substance which gives the reactions of a nitrite; what its composition is has not been ascertained. The amount of such nitrite reacting substance in commercially bleached flour varies ordinarily from less than one part to five or six parts of nitrogen in one million parts of flour.

Food Commissioner Ladd of North Dakota has reported¹ that poisonous materials are introduced in the bread in the bleaching process, naming particularly the nitrites. In conjunction with Bassett he has published² the results of digestion tests on bread where the bleached flour bread seemed to be more difficult of digestion than that made from unbleached flour. Shepard³ tested the action of nitrous acid on the digestive enzymes and found that while small amount did not interfere with their action

¹Ladd and Stallings, Bulletin 72. Experiment Station of North Dakota. November, 1906.

²Ladd and Bassett. Journal of Biological Chemistry, March, 1909.

³Shepard. Food Law Bulletin, III, 153. August 12, 1908.

larger ones did so. He did not try the digestibility of the bleached flour alone, however. An application for an injunction to prevent the prohibition of the sale of bleached flour in North Dakota was denied, not because there was proof that the flour was injurious to consumers but because the statute forbidding the addition of any antiseptic materials to food-stuffs was broad enough to include the nitrite-reacting material formed in the flour during the bleaching. After a hearing in Washington, Secretary of Agriculture Wilson has decided that bleached flour cannot be an article of interstate commerce. Recently Halliburton⁴ has reported a lessened digestibility of flour products due to the bleaching agent.

On the other hand, Alway⁵ and Snyder⁶ found that in the bread-raising and baking process practically all the nitrite reacting substance disappeared from the bread if yeast is used. Wesener and Teller⁷ showed that in their experiments there was no difference in the digestibility of the bread from bleached and unbleached flour, a conclusion at which Snyder also arrived.

In the experiments reported below tests have been made on the digestion of the starch of the cooked flour by the ptyalin, of the peptic digestion of moist gluten and of bread, and of the digestion of the starch of cooked flour and of uncooked dry gluten by the pancreatic ferments. In all cases the flours used were from the same mill, one being bleached and the other being unbleached. The same amount of flour and digestive solutions were used for each test, the two samples being treated side by side under the same conditions.

SALIVARY DIGESTION.

While in parallel tests the amount of flour was the same in the bleached and unbleached sample, in different series the amount was varied, but was generally from two to four grams of flour, boiled with water and diluted to a liter. A measured volume of saliva was added with a few drops of a solution of iodine in potassium iodide and the two samples were kept in a constant temperature water bath at 38 degrees. The progress of the digestion was judged by the change of color from a deep blue through a violet and reddish to a colorless—what Halliburton calls the achromic point. Table I gives some of the typical results.

⁴Halliburton, *Journal of Hygiene*, September, 1909.

⁵Alway, *Bulletin of the Agricultural Experiment Station of Nebraska*, Vol. XX, Article III, October, 1907.

⁶Snyder, *Bulletin III. Agricultural Experiment Station, University of Minnesota*, August, 1908.

⁷Wesener and Teller. *Journal of Industrial and Engineering Chemistry*, 1: 700. October, 1909.

TABLE I.
SALIVARY DIGESTION.

TIME OF REACHING ACHROMIC POINT.		
Test.	Bleached.	Unbleached.
I	3¾ min.	3¾ min.
II	3¾ min.	3½ min.
III	23 min.	24 min.
IV	7 min.	9½ min.
V	Same for both.	
VI	Same for both.	
VII	Achromic point reached at same time; speed of digestion same as shown by shade of color.	
VIII		
IX		

While there was slight variation in individual cases it was not always in the same direction and the conclusion reached is that there is no difference in the digestibility of the flour.

PEPSIN DIGESTION.

A. Of Moist Gluten. The gluten was separated from the flour by the usual method—thorough moistening, then washing out the starch under a water-tap until the wash water was not milky. While most of the starch was removed in this manner some remained, as shown by the iodine test, after long washing. The water was removed as far as possible by pressure in a towel, the moist gluten immediately weighed out in equal quantities, the lumps rolled up into the same shape and put into flasks containing pepsin in 0.2 per cent hydrochloric acid. The flasks were kept in water at 38 degrees, being shaken occasionally and at equal intervals. The degree of digestibility was determined by finding the amount of nitrogen in the solution and in the residual gluten. Table II gives the results of three tests on the same gluten.

TABLE II.
PEPSIN DIGESTION OF MOIST GLUTEN.

		Bleached.	Unbleached.
1½ hours.....	Soluble	0.0494 grm.	0.0469 grm.
	Insoluble	0.2258 grm.	0.2181 grm.
	Total	0.2752 grm.	0.2650 grm.
2½ hours.....	Soluble	0.0709 grm.	0.0737 grm.
	Insoluble	0.2032 grm.	0.1972 grm.
	Total	0.2741 grm.	0.2709 grm.
3½ hours.....	Soluble	0.0995 grm.	0.0916 grm.
	Insoluble	0.1776 grm.	0.1836 grm.
	Total	0.2771 grm.	0.2752 grm.

The limit of accuracy is indicated by the discrepancies between the total amounts of nitrogen which should, of course, have been the same, inasmuch as the samples of gluten were prepared at the same time. These differences were undoubtedly due to variation of water in the different portions. They are not great and not all in the same direction. There is no indication, then that the gluten digests at a different rate if bleached or unbleached.

B. Of Bread. The bread made under domestic conditions, was raised with yeast and baked in a kitchen range, dried, finely pulverized, to produce as far as possible the same surface of the particles, and digested with pepsin-hydrochloric acid under the same conditions as the moist gluten. The degree of digestibility was determined by the proportion of nitrogen which went into solution. Table III shows results.

TABLE III

PEPSIN DIGESTION OF BREAD.

PER CENT OF ORIGINAL NITROGEN DIGESTED.

Test	Bleached	Unbleached
I	60.8	57.2
II	69.5	69.8
III	82.9	86.6

While there is not absolute agreement nothing indicates that the protein of the bleached flour is less digestible than that from the unbleached.

PANCREATIC DIGESTION.

A. Starch Digestion. This was carried on as with the salivary ferment, Merck's pancreatin being substituted for the salivary ferment.

B. Gluten Digestion. The gluten was extracted from flour as before described and thoroughly dried at 100 degrees, then finely ground with a coffee grinder. Digestion was carried on at 38 degrees, the soluble nitrogen being used to indicate the amount digested. Table IV shows results.

TABLE IV.

PANCREATIC DIGESTION OF STARCH.

TIME OF REACHING ACHROMIC STAGE.

Flour Contains 2.68 Parts Nitrite N per Million.

Test.	Bleached.	Unbleached.
I	4 min.	3½ min.
II	35½ min.	37½ min.
III	35 min.	33 min.

PANCREATIC DIGESTION OF DRY GLUTEN.

Percentage of Original Nitrogen which was Digested.

Test.	Bleached.	Unbleached.
I	75.0	73.1
II	63.4	67.9

Here, again, the bleaching does not seem to affect the power of the digestive ferment.

To sum up the results—no indication has been found that when carried on under the same conditions, the power of the digestive enzymes is affected in any way by changes in wheat flour due to the nitrogen peroxid bleaching process. Unless the conditions are carefully kept the same the results of digestive tests may differ widely.

THE EFFECT OF CONTINUED GRINDING ON WATER OF
CRYSTALLIZATION.

BY NICHOLAS KNIGHT.

Mauzelius (Sveriges Geol. Undersökning Arsbok 1 1907); Day and Allen (Bull. U. S. Geol. Survey, 305, p. 35), Hillebrand (Journ. Am. Chem. Soc. xxx 7) and Knight (Chem. News xcvi 122) have shown the effect of fine grinding on the water and ferrous content of minerals and rocks. In this paper we are able to show the effect of continued grinding on some hydrates. The water was determined in each specimen after grinding it a half hour, an hour, an hour and a half, and two hours. The two hours' grinding seemed to give the maximum results. The grinding was done by hand in an ordinary Wedgewood mortar. In each determination, exactly one gram of the substance was weighed into a porcelain crucible and the water was removed by heating to constant weight with a Tirrell burner. For purposes of comparison, the water was first determined in the unground specimens. All the conditions were maintained as nearly uniform as possible.

1. Magnesium Sulphate—	Water (per cent)
The unground crystals	51.85
After two hours' grinding.....	49.30
Removed by grinding	2.55
2. Sodium phosphate—	Water (per cent)
The unground crystals	58.61
After two hours' grinding	56.76
Removed by grinding	1.85
3. Potassium Alum—	Water (per cent)
The unground crystals	45.47
After two hours' grinding	44.98
Removed by grinding	0.49

The unground specimens swelled to such an extent that great care was necessary in the heating to prevent the alum from creeping over the walls of the crucible. After grinding to a fine powder there was no such difficulty, as the substance fused to a hard ball in the bottom of the crucible.

4. Barium Chloride—	Water (per cent)
After grinding two hours.....	17.06
The unground crystals	14.95

The grinding increased the amount of water..... 2.11

This result was unlooked for but repeated trials showed the same increase. While at first the substance seemed dry, by continued grinding it became moist and sticky.

5. Copper Sulphate—	Water (per cent)
The unground crystals	35.88
After two hours' grinding	34.95
Removed by grinding	0.93

The substance changed from a bright blue to almost white in the grinding process. In both cases heat was applied very carefully to prevent the decomposition of the copper sulphate.

6. Ammonium Alum—	Water (per cent)
The unground crystals	47.29
After two hours' grinding	46.96
Removed by grinding	0.33

The substance was difficult to grind toward the end of the operation as it would harden to the mortar from which it was difficult to be removed. This was most easily effected with a platinum spatula.

7. Sodium Alum—	Water (per cent)
The unground crystals	37.89
After two hours' grinding	23.84
Removed by grinding	14.05

The result was surprising, but three trials showed the same large difference.

8. Iron Alum—	(Water (per cent)
The unground crystals	41.24
After two hours' grinding	29.84
Removed by grinding	11.40

The substance became so firmly attached to the mortar that it could be removed only with a platinum spatula.

9. Iron Sulphate—	Water (per cent)
Unground crystals	38.64
After two hours' grinding	24.63
Removed by grinding	14.01

The substance was difficult to grind on account of adhering so tenaciously to the mortar. We therefore substituted a large agate mortar and pestle that seemed unusually hard and well polished, not having been used before. This rendered the grinding of each substance much more satisfactory.

10. Calcium Sulphate, transparent selenite—

The unground crystals	20.90
After two hours' grinding	17.66
Removed by grinding	3.24

11. Sodium Thiosulphate—

Unground crystals	36.19
After two hours' grinding	24.43
Removed by grinding	11.76

12. Barium Chloride—

We decided to repeat the experiment (4) on account of the unexpected result.

The unground crystals	14.76
After two hours' grinding	14.85
The grinding increases the amount of water.....	.09

A number of trials gave the same result. The crystals become moist and sticky by continual grinding.

13. Borax—

Unground crystals	41.62
After two hours' grinding	31.08
Removed by grinding	10.54

14. Strontium Chloride—

Unground crystals	35.66
After two hours' grinding	23.22
Removed by grinding	12.44

Thanks are due Miss Florence Klaus and I. B. Bleeker for all the determinations described in this paper.

A STUDY IN THE DETERMINATION OF CALCIUM.

BY GEORGE HEISE.

In this series of experiments it has been attempted to simplify the gravimetric determination of calcium, to make it a more satisfactory and convenient laboratory method.

The precipitation of calcium as the oxalate and its subsequent conversion by heating to the oxide is a method which presents some difficulties, especially to the inexperienced student. To entirely convert all the calcium to the oxide is a long and tedious process at best, besides, especially when porcelain crucibles are used, it is almost impossible to heat the oxide down to constant weight.

It occurred to us that it might be feasible to precipitate calcium as the oxalate in the usual manner, to filter it through a Gooch crucible, to weigh it directly as the oxalate, or to change the oxalate to the carbonate by careful heating, and to weigh as the carbonate.

A careful search through the literature revealed only one article* in which the conversion of the oxalate into the carbonate by heating is recommended as a method for the gravimetric determination of calcium (Strontium, Barium). The heating was done in a capped Gooch crucible over a free Bunsen flame. No precautions or special directions were given and the results, though fairly accurate, were low in each case, showing the partial decomposition of the carbonate into the oxide.

It shall be my endeavor to show how calcium may be determined directly as the oxalate in a Gooch crucible and how the oxalate may be converted into the carbonate by heating without danger of loss by decomposition.

A carefully weighed amount of the purest obtainable calcite was introduced into a graduated litre flask, covered with dilute HCL and allowed to decompose. The flask was then filled to the mark with water. The solution, which was perfectly clear and free from residue, was kept in a glass-stopped bottle and convenient quantities for analysis were withdrawn as needed by means of a graduated pipette.

*Estimation of Calcium, Strontium and Barium as the Oxalates (with KMNO).
Am. Jour. Sci. Series 4-I. (1901) 216..

The precipitation of calcium was performed in accordance with the method described by T. W. Richards.* Oxalic acid was added to the hot, acid solution of calcium chloride, the solution was then made just alkaline by the slow addition of ammonia, methyl orange being used as an indicator, finally excess of ammonium oxalate was added and the precipitate was allowed to stand about four hours.

Ordinary glazed porcelain Gooch crucibles with porcelain plates and asbestos mats were used for filtration. Calcium oxalate filters somewhat slowly but the filtrate comes through perfectly clear. The precipitates were washed with a dilute solution of ammonium oxalate, finally with a little water.

Calcium oxalate precipitates with either one or three molecules of water of crystallization, and gives up this water at 205 degrees centigrade. Heating the oxalate for from thirty to forty-five minutes in a drying oven at a temperature of 225-250 degrees was found sufficient to dehydrate it completely. It behaves very much like the oxide, taking up moisture from the air very readily. It is necessary to heat, weigh, reheat for ten minutes, dessicate a second time and reweigh rapidly to get the correct weight. It is generally possible to get within one or two milligrams of the correct weight at the first trial. The results obtained show that it is practicable to determine calcium quickly and accurately as the oxalate. In heating, I found that the oxalate would not decompose though it was heated for an hour at 340 degrees.

As will be seen from the first table (below), the results are well within the limits of experimental error. However, to confirm the results obtained or to find the error, if any, it was thought wise to weigh also as carbonate, if some surer method of converting the oxalate could be devised. Determinations 1 and 2 were heated over a low Bunsen flame without any special precautions, dessicated and weighed. In subsequent determinations, the crucibles were heated high over a moderately large Bunsen flame to incipient redness and fairly accurate results were obtained.

A table showing the results of the first series of determinations follows:

*Ztschr. fuer Anorg. Chemie, 28-170-(1901).

TABLE I.

DETERMINATIONS IN PORCELAIN GOOCH CRUCIBLES.

Number	Weight of Oxalate	Calculated Weight	Error	Weight of Carbonate	Calculated Weight	Error
1.-----	0.4870 g	0.4867 g	+ .0003 g	0.3850 g	0.3802 g	+ .0048 g
2.-----	.4870 g	.4867 g	+ .0003 g	.3830 g	.3802 g	+ .0028 g
3.-----	.4875 g	.4867 g	+ .0008 g	.3818 g	.3802 g	+ .0016 g
4.-----	.4870 g	.4867 g	+ .0003 g	.3816 g	.3802 g	+ .0014 g
5.-----	.1942 g	.1947 g	- .0005 g	.1510 g	.15209 g	- .0011 g
6.-----	-----	.1947 g	-----	.1526 g	.15209 g	+ .0005 g

Note.—Calculations are based on weight of calcite.

The first preliminary determinations having succeeded so well, the second series was begun, this time in a platinum Gooch, to make possible the weighing of calcium not only as the oxalate and carbonate, but also as the oxide. Thus a double check on the accuracy of the work could be secured. In this series it was likewise attempted to devise a clean-cut and efficient method of converting the oxalate into the carbonate, without necessitating the weighing as oxide to check results. Most teachers would hesitate to advocate weighing of calcium as the carbonate unless more certain and specific directions for the conversion of the oxalate could be laid down.

The oxalate was precipitated in the usual manner and weighed in a covered Platinum Gooch crucible. For the conversion to the carbonate the following scheme was devised:

The Gooch crucible was placed on a thin piece of asbestos in a large iron crucible. The iron crucible was then covered with a porcelain cover and heated to the highest possible temperature over a full Bunsen flame.

The results obtained were as accurate as could be wished for. Heating by this method for 20-30 minutes brought the carbonate down to constant weight and eliminated all danger of decomposition by superheating.

As an added check the carbonate was converted to the oxide in a blast lamp, using a capped platinum Gooch, yielding results concordant with the calculated value in each case.

The second series follows:

TABLE II.
DETERMINATIONS IN PLATINUM GOOCH.

Number	Weight of Oxalate	Calcu- lated Weight	Error	Weight of Car- bonate	Weight of Oxide	Calcu- lated Weight	Error
8-----	0.3912 g	0.3911 g	+ .0001 g	0.3056 g	0.1710 g	0.1711 g	— .0001 g
9-----	0.3945 g	.3938 g	+ .0007 g	.3076 g	.1722 g	.1722 g	.0000
10-----	.3916 g	.3913 g	+ .0003 g	.3058 g	.1716 g	.1713 g	+ .0003
11-----	.8666 g	.8666 g	.0000 g	.6770 g	.3794 g	.3791 g	+ .0003
12-----	.8820 g	.8819 g	+ .0001 g	.6890 g	.3858 g	.3858 g	.0000

Note.—Calculated weights based on weights of carbonates.

The results of these experiments may be briefly summarized as follows:
Calcium can be determined and accurately weighed as the oxalate.

It can be very conveniently converted into the carbonate and weighed as such.

The determinations can be carried out in porcelain crucibles without appreciable error.

Either of the above mentioned methods is fully as accurate as the determination of calcium as the oxide and is much more convenient and rapid.

Of the two methods, the determination as carbonate is somewhat superior to the determination as oxalate, because of the hygroscopic nature of the latter substance.

I wish at this time to express my thanks to Professor W. S. Hendrixson for his suggestions and help in the working up of this series of experiments.

POINTS REGARDING THE CASING OF WELL (4) AT GRINNELL

BY W. S. HENDRIXSON.

In the second paper on "Iowa Ground Waters" read before the Iowa Academy of Science at the annual meeting of 1909, the writer, in connection with the subject of the corrosion of well casings called attention to the fact that the city of Grinnell had contracted for a casing of cast iron for well number (4) which was then being drilled. It was suggested that a report would be made on the practicability of this enterprise at a later meeting.

The casing of well number (4) was placed and the well was first pumped about January 20, 1910. So far as I have been able to learn through the Geological Survey, or indirectly from the drillers, the makers of the tubing or from the literature, the successful lowering of a well casing of such great length is new, at least in the Mississippi valley, and it seems desirable to prepare a statement of the facts concerning the undertaking for record in the proceedings of the Academy of Science. It may be said, however, that casing of cast iron have been placed in much shallower wells, 200 to 300 feet, in Minnesota.

To make clear the reasons for this departure from the usual custom of casing wells with iron or soft steel tubing a few facts in the experience with deep wells in this town may be stated. The first deep well at Grinnell, depth 2,003 feet, was completed in August, 1893. The well was not very satisfactorily bored or cased. The hole was not straight, and owing to an accident there was a break in the casing from rock, 208 to 408 feet, permitting the entrance of the very hard water at the base of the drift. It is not probable that with ordinary pumping the well supplied much water from the deep lying sand-stones, the St. Peter and the New Richmond. In fact the results of the analysis of the water were almost identical with those obtained from the waters of wells in the neighborhood having depths of 250 to 450 feet. In a few years the demands of the growing town exceeded the water supply obtainable from the well. This fact together with the danger of having the supply cut off entirely by a breakdown of the machinery, caused the city to put down well number (2). It was cased continuously to about 840 feet.

Not long after the completion of well (2) an examination of well (1) showed that it had been filled to a distance of 800 feet from the bottom by caving shale. Attempts to clear the bore of this material proved unavailing. What was left of the casing could not be drawn or cut out. Small sections of it were obtained and were found to be thin and full of holes. The well was abandoned and a new one begun in 1905. Soon after the completion of well (3) the capacity of number (2) became rather suddenly much reduced, and an examination showed the same difficulty as in number (1); that is, the caving of shale. The well was cleared to about 1,600 feet, where seemingly insuperable difficulties were encountered and the well was also abandoned.

It was now evident that to continue to drill and abandon wells at this rate would prove a very serious tax on the resources of the city, and that some radical changes should be made in the casing of such wells. The casing should evidently extend below the shale that had caused trouble by caving, and the desirability of securing more durable casings became evident. So far as known to me the idea of a cast iron casing originated with Mr. Henry Simmon, at that time the city engineer. He talked with the writer from time to time, and as the idea finally developed, it was to sink a casing to just above the St. Peter sand-stone, 1,700; and to fill the space between the tube and the walls of the well with cement. Of course, his opinion gained from much practical experience, was that cast iron tubing of good quality would outlast iron tubing several times. This, in fact, seems to be the common experience, but one who undertakes to find proof of the great durability of cast iron over wrought iron, as deduced from scientific experimentation, will find difficulty. The literature is full of comparative tests of the relative durability of wrought iron and steel, when exposed to water or the soil. This is probably owing to the great practical importance of the matter in relation to boiler construction. There seems to be very little on the comparative corrosion of wrought iron and cast iron. The data, such as we have, are somewhat conflicting, but on the whole indicate that cast iron will outlast wrought iron two to four times. Cast iron seems to have exceptional ability to hold a pitch enamel, which may extend its durability far beyond the above figures.

The original intention was to case well (4) with cast iron tubing to 1700 feet and the contract with the J. P. Miller Artesian Well Company of Chicago was so drawn. But, great difficulties were encountered when the attempt was made to ream out the lower part of the drilling. Shale caved from above, tools were fastened and some of them were broken away. For several months work was discontinued and there was some talk

of abandoning the well. Finally an agreement was reached to clear the well to the bottom and place the foot of the casing at 1460 feet. The work of putting down the casing progressed rapidly and without difficulty, proving the practicability of sinking casings of such dimensions. Three short sections were lowered, and the final 600 feet were put down in one piece. The sections of tubing as they were received were screwed together with wrought iron couplings, so threaded that the cast iron sections came into contact. The long sections as they were lowered into the well, were connected by ground joints.

The length of the casing has been given. Certain other facts that may be of interest are as follows: The diameter of the casing is $5\frac{5}{8}$ inches, and the weight 31 pounds to the foot. The tubing was supplied as a special order by the United States Cast Iron Pipe and Foundry Company, 71 Broadway, New York, at a cost of \$1,040, which is very little more than the cost of wrought iron tubing.

It is to be regretted that the original contract could not be adhered to. A casing to the St. Peter sand-stone would have prevented possible caving of shale. From both the scientific and practical standpoints it would have been of much interest to know the quality of water drawn from the St. Peter and New Richmond sand-stones only, and to have known the capacity of those formations to supply water in this part of the state. The well has apparently shown no signs of exhaustion in the course of the ordinary pumping of the last few months.

An analysis of the water shows that its mineral content is about the same as that of the water from well number (2) when in the best of condition; that is, about 900 parts per million. The best water analyzed from well number (3) contained about 1,100 parts per million. There is a tradition handed down from the date of drilling the first well that there is a flow of very highly mineralized water at about 1,550. If so, the water from well (4) would be contaminated by this hard water. Mr. L. Nichols, in charge of the construction of well (4), discredits the existence of this flow. It is his opinion, rather, that there are small flows of water from point to point in the thick layers of limestone above the St. Peter, but that the whole is comparatively insignificant. If this opinion be correct it seems probable that the quality of the water now supplied by the well may not be very different from that of the combined waters of the St. Peter and New Richmond sand-stones at this point.

STUDIES IN THE SOLUBILITY OF PORTLAND CEMENT CONTINUED FROM 1908.

BY G. G. WHEAT.

In the year 1908 we presented a brief paper before the Academy of Science, calling attention to certain uses of portland cement concrete for farm drainage and city sewer purposes and in that connection raised the question of the fitness of the material for the use made of it. The importance of the question has greatly increased, as the spirit of improvement and progress is running like wildfire over our state.

Approximately \$300,000,000 will be spent in reclaiming wet lands of the Wisconsin Drift region of Iowa. Of this perhaps \$30,000,000 will be open drainage ditches, the remaining \$270,000,000 being the cost of drain tile and the cost of laying.

Perhaps as much more will be spent in the remaining sixty-nine counties. The rapid advance of our cities and villages in sewerage systems will call for an expenditure of fully one-tenth as much in sewer systems, the grand total being not less than between six and seven hundred millions.*

When compared with the cost of the Panama Canal, quite accurately estimated at from three hundred seventy-five to four hundred millions, its importance becomes more manifest. In view of the fact that all construction is underground and most of it impossible to inspect, the necessity of perfect materials is obvious. Since the crops upon the millions of acres to be drained will depend upon the free circulation of ground waters through the tile systems, the importance of the nature of the materials, as related to our future food supply, asserts itself, and perhaps more important than all, the health of our citizens in our villages and cities depends upon pure water for the household and a perfect elimination of all excreta from the city and from its soil.

In this last collection the recent reports from the city of LeMars are of interest. Sewage contamination of the city water led to the examination of the sewer system. A break in the sewer manhole connections

*Note.—These calculations are based upon the actual amount expended to date in thirty counties, the actual acreage cost and the acres remaining yet to be done. These records were personally taken from the county records by the writer.

was repaired and it was expected that the trouble would cease. Later the writer visited the city, inspected a number of manholes and found that considerable of the cement mortar in the bottom of manholes is in various stages of decay, some crumbles readily and is easily removed. This condition should it prevail in the mortar joints of pipe lines, offers an outlet in the ground water in the gravel beds which supply the city water. The matter has gone into the courts, meanwhile the people's health is at the mercy of escaping sewage and poisoned household water.

A continuation of the studies suggested two years ago called for a definite inquiry as to the exact power of pure distilled water to act upon the substance of portland cement. Mr. Orin L. G. Kipp, now assistant professor at Ames, carried out tests in the school year of 1908-9.

Samples were taken from a number of twelve-inch concrete pipe. These were chosen to study two conditions of pipe. Some of these pipe rang clear and strong under the testing hammer and when submitted to the crushing test carried a load of far more than the required strength. The broken section showed dense, close concrete with plenty of cement. These pipe carried a load equal to 77% of first class vitrified pipe tested on the same machine and the same method of contact. These samples were chosen as being representative of the better quality of concrete now being manufactured in the state of Iowa.

In preparing a sample for testing, a piece about an inch square was broken off and all the loose pebbles or sand brushed from it. The sample was then heated in an oven at about one hundred degrees C. until constant weight was obtained. After weighing the sample, it was placed in a Gooch crucible which was lined with a filter cup, and this was suspended at the lower end of the inverted condenser projecting into a Soxhlet extractor. The bowl of this extractor was filled about two-thirds full of distilled water, and the flame lighted below it.

As this method of producing a flow of water over the concrete might be subject to criticism on account of the fact that the water flowing over the concrete was hot, a piece of special apparatus was constructed which allowed the water to flow over the concrete at normal temperature. This special apparatus is shown in the figure below, a slight study of which will make its working clear. The steam passes from the bowl of the tube to the right and into the condenser from which the cold water flows over the piece of concrete, "A," and then flows back to the bowl at intervals as the receptacle below fills and syphons over.

In order that a fair comparison of the action of cold and hot water might be obtained, two samples as nearly alike as possible were taken from the same piece of concrete, and after being prepared in the usual

manner, one was placed in the special apparatus and the other in the ordinary extractor. The per cents dissolved under the two conditions I will dwell upon later.

After an extractor had run for a period, the length of which was generally chosen at 120 hours, the bowl and its contents were replaced by another bowl containing a fresh supply of distilled water. The dissolving process was then continued for another period.

As soon as a bowl was removed the analysis of its contents was begun. The bowl was placed in a sand bath and the water evaporated to dryness. It was then heated in an oven and cooled in a bell jar. Even where this method was followed, some difficulty was experienced in obtaining the exact weight, as the contents of the bowl gathered moisture as soon as exposed to the air. After weighing, the bowl was filled with dilute HCl and kept on a sand bath for about three days or until the deposit which adhered to the glass could be rubbed loose with a "Police-man." By this process the greater portion of the contents could be removed to an evaporating dish and evaporated to dryness. It generally happened, however, that upon drying, the bowl still showed a white film adhering in spots. To recover this, the bowl was filled with Ammonium Hydrate and again placed in the sand bath for a time. This second amount was likewise evaporated to dryness, then made slightly acid with HCl and added to the first. The bowl was weighed after being dried in an oven and cooled in a bell jar. The total amount removed was then treated to a regular dolomite analysis.

The results of these analyses, together with the per cent that was dissolved out each time, the total per cent dissolved from the piece, the length of the individual running and the total time run are all given in tables I, II, III and IV.

Tables I and II are especially interesting since in them are summarized the results obtained in running the two samples of the same piece of concrete at different temperatures. From the results obtained it appears that the cement is fully as soluble in the cold water as in the hot. We may, therefore, conclude that results obtained when the water was hot are as fair as though the water had been cold in every case. We purposely chose Sample No. 1 for this comparative test because it seemed to be much the best of any of our samples. That it was the best of any we ran is shown by results obtained from Nos. 2, 3, 4 and 5. All of these latter samples were either partially or wholly disintegrated at the end of the last running, yet, while No. 1 was run in both hot and

cold water much longer than any of these, in neither case had it wholly disintegrated, though it was much reduced in size.

In order to ascertain the exact nature of those quantities given in the foregoing tables under the head "Insoluble," a number of these precipitates were fused in a platinum crucible with Na^2CO^3 . The results of the analyses which were made following the fusion are shown in Table V. These analyses showed a very large per cent as still insoluble. To assure myself fully that this part was SiO^2 , I placed several of these precipitates in platinum crucibles and moistened with sulphuric acid and then hydrofluoric acid was added and the whole volatilized. This process left only a slight discoloration on the platinum. Suspecting that this was largely iron, I tested it with potassium ferro-cyanide and obtained the blue color which this gives with iron. The per cent given as SiO^2 , while it is practically all this, really includes, therefore, a small trace of iron.

TABLE I (NORMAL).

NO. 1: TEMPERATURE OF WATER, 98° C.

	First Running	Second Running	Th.rd Running	Fourth Running	Fifth Running
Weight of piece.....	7.1120	6.3376	5.8701	5.5690	5.1410
Insoluble	.2428	.2086	.1795	.1857	.1880
Al_2O_3 and Fe_2O_3	.0617	.0427	.1040	.0353	.0224
Ca CO_3	.4655	.2148	.0044	.2014	.1412
Mg CO_3	.0044	.0014	.0132	.0056	.0059
Per cent dissolved	10.89	7.38	5.13	7.69	6.95
Total per cent dissolved..	10.89	17.46	21.69	27.71	32.74
Time run	120 hrs.	120 hrs.	120 hrs.	120 hrs.	120 hrs.
Total time	120 hrs.	240 hrs.	360 hrs.	480 hrs.	600 hrs.

TABLE II (NORMAL).

NO. 1: TEMPERATURE OF WATER, 17° C.

	First Running	Second Running	Third Running	Fourth Running	Fifth Running
Weight of piece.....	6.8130	6.2704	5.7063	5.2784	4.8123
Insoluble	.3555	.3960	.3040	.3335	.3460
Al_2O_3 and Fe_2O_3	.0406	.0203	.0435	.0260	.0182
Ca CO_3	.1416	.1446	.0787	.1038	.1184
Mg CO_3	.0048	.0032	.0017	.0029	.0034
Per cent dissolved	7.96	8.99	7.50	8.83	10.10
Total per cent dissolved..	7.96	16.24	22.52	29.37	36.50
Time run	120 hrs.	120 hrs.	120 hrs.	120 hrs.	120 hrs.
Total time	120 hrs.	240 hrs.	360 hrs.	480 hrs.	600 hrs.

TABLE III.

TEMPERATURE OF WATER 98°C. IN EACH CASE.

	Sample No. 2			Sample No. 3		
	First Runni'g	Second Runni'g	Third Runni'g	First Runni'g	Second Runni'g	Third Runni'g
Weight of piece.....	9.0395	7.9221	7.2923	10.1065	9.1416	8.2156
Insoluble	.2690	.2817	.1530	.2628	.3430	.3015
Al ₂ O ₃ and Fe ₂ O ₃	.0373	.0493	.0941	.0483	.0695	.2138
Ca C O ₃	.7946	.2934	.0500	.6479	.5110	.0125
Mg C O ₃	.0165	.0054	.0064	.0049	.0025	.0212
Per cent dissolved	12.36	7.95	4.13	9.54	10.13	6.68
Total per cent dissolved...	12.36	19.33	22.68	9.54	18.70	24.13
Time run	120 hrs.	120 hrs.	120 hrs.	120 hrs.	120 hrs.	120 hrs.
Total time	120 hrs.	240 hrs.	360 hrs.	120 hrs.	240 hrs.	360 hrs.

TABLE IV.

TEMPERATURE OF WATER, 98° C., IN EACH CASE.

	Sample No. 4			Sample No. 5		
	First Runni'g	Second Runni'g	Third Runni'g	First Runni'g	Second Runni'g	Third Runni'g
Weight of piece.....	10.3076	8.4970	7.9158	10.4800	8.6093	-----
Insoluble	.6104	.2000	.2510	.6004	.1845	-----
Al ₂ O ₃ and Fe ₂ O ₃	.0328	.0315	.0405	.0292	.0366	-----
Ca C O ₃	1.1121	.3446	.4610	1.1809	.2777	-----
Mg C O ₃	.0553	.0051	.0059	.0656	.0023	-----
Per cent dissolved	17.56	6.84	9.58	17.90	4.78	-----
Total per cent dissolved...	17.56	23.20	30.56	17.90	22.68	-----
Time run	96 hrs.	96 hrs.	96 hrs.	96 hrs.	96 hrs.	-----
Total time	96 hrs.	192 hrs.	288 hrs.	96 hrs.	192 hrs.	-----

The power of the water at 17°C. was appreciably greater than at 98°C. The reason for this, as assigned by Dr. W. R. Whitney, President of the American Chemical Society, is that the water at 17°C contained a larger amount of C O², dissolved out of the air. We stated, two years ago, that all the results entered into mineralogical literature showed a definite power for C O² waters and other acid waters of the soil to act upon all minerals containing calcium, to remove the calcium in solution. Observe the following:

(Clarke, Data of Geochemistry, Bulletin 330, U. S. Geological Survey, p. 165.) "Meteoric waters carrying free carbonic acid are probably the most powerful of agents in the solution of rocks, although their

chemical activity is neither violent nor rapid. Being continually replenished from the storehouses of the atmosphere, their work goes on unceasingly over a large portion of our globe. The calcium which they extract from rocks is carried by rivers to the sea and is finally deposited in the form of limestones. * * * * * Alkaline waters, especially thermal waters of the sodium carbonate class, are also active solvents of mineral substances. Their tendency, however, is opposite to that of the acid waters, for they dissolve silica rather than bases and act as precipitants for magnesia and lime."

The portland cement, being calcium silicate and calcium aluminate, is acted upon readily by the carbonate or other acid waters to dissolve out the calcium, and is also acted upon by the alkaline waters, which replace the calcium and combine with the silica. In either case the integrity of the original silicate has been destroyed and it is no longer a bonding material to hold sand and gravel combined in an artificial stone.

Van Hise' Treatise on Metamorphism, U. S. Geological Survey, gives the factors affecting the alteration of rocks. "Porosity is favorable to rapid change; to contain minerals which are soluble is favorable; to contain water or gas is favorable for rapid alteration." The concrete tile and sewer pipe now manufactured are invariably highly porous. Their mineral content is readily acted upon and dissolved by the free access of solvent acids or alkaline waters to all parts of the porous material. The content of water is large, as the bonding material has derived all its bonding power by a rehydration of the ground cement clinker. Van Hise says: "The greatest destruction of materials occur in the belt of weathering. This belt extends from the surface to the level of ground-water, the greatest destruction occurring at ground-water level." Drain tile is always at groundwater level, for they themselves determine this level. Van Hise assigns the greatest relative importance to CO_2 , as it is everywhere at work upon the surface of the earth and is always active and is immeasurably the most important in the belt of weathering. And again: "The one liquid through which the greater part of all alteration of rocks occurs is water solutions." Kahlenberg and Lincoln, Journal of Physical Chemistry, Vol. 2, p. 1898, holds that "When dilute solutions of silicates are made in groundwaters, the silica exists in the form of colloidal silicic acid." Ostwald divides the bases into the strong, moderate and weak. In the belt of weathering the alkalis, sodium and potassium, are dissolved first, next comes calcium, the magnesia, iron and aluminum dissolving last. Van Hise summarizes the importance of these studies in a paragraph:

“The two great acids of nature are carbonic and silicic and the major contest in the rocks, so far as the acids are concerned, is between the weak carbonic and the very weak silicic: * * * * * The fact of the formation of carbonates and the simultaneous decomposition of the silicates under surface conditions the world over is well known.”

The limits of our space do not permit a more extended presentation of our studies. You will be gratified—following the interest which you so generously displayed two years ago and today—you will be gratified to know that the mining engineering and chemistry departments of several of our colleges and state institutions are pursuing most thorough and careful studies of the action of groundwaters, acid and alkaline, and sewage waters upon the body of cement concrete and we urge again your continued interest and co-operation.

SOME GEOLOGICAL ASPECTS OF ARTIFICIAL DRAINAGE IN IOWA.

BY G. G. WHEAT.

Nature's unfinished work in the Wisconsin drift areas of Iowa has left the lands peculiarly subject to submergence in times of heavy precipitation. The magnitude of the drainage projects which would be required to carry out the incomplete work of Nature's young river systems, for a long time held back the development of drainage. Recent legislation, making possible the creation of drainage districts upon the petition of a reasonable number of land holders interested, has led to a most rapid growth in farm land drainage. Those who are familiar with the topography of the Wisconsin Drift area, in the counties of Cerro Gordo, Hancock, Palo Alto, Eastern Clay, Humboldt, Pocahontas, Eastern Buena Vista, Calhoun, Webster, Hamilton, Worth, Winnebago, Kossuth, Emmet and Dickinson, are aware that the Des Moines, Iowa and Cedar rivers have developed very few tributaries; that these are not deeply eroded and that the headwaters of these branches frequently rise in a marsh. The second typical feature of this region is the saucer-like basins or upland ponds, which usually have no outlet, except that one side may be a little lower than the other by a few inches. Drainage districts in this area almost always show chains of these ponds, united by extremely shallow depressions, unworthy of the name of ravine, coulee, or even swale. Depressions so slight as to be invisible to any but the practiced eye, when the fields are uniform in color in winter.

The methods used at present in drainage, are those which first suggested themselves to the mind of man who has no other desire than to get rid of the water. Beginning at some point where an outlet can be secured, at the lower end of the drainage system, open ditches are constructed, leading toward the upper limits of the water-shed. Frequently other open ditches are branched from this in dendritic system, although sometimes a drainage plat makes me want to use another term and say, the branches are in hieroglyphic fashion. When the open ditch has been carried far enough so that a 30-inch diameter tile is sufficient to take care of waters from the remaining water-shed above, tile are then laid, the extreme limits of the drainage system being the last small branches laid by individual farmers, draining their acres.

The magnitude of some of these undertakings may have been overlooked by some members of the academy. Kossuth County has one drainage ditch costing in the neighborhood of \$483,000 for the mains alone. The laterals which the land owners will lay will amount to fully four times the cost of the original ditch, making a total expenditure of approximately \$2,500,000. This project is a logical extension of the East Branch of the Des Moines River and brings easily and quickly within the water-shed this acreage which formerly has had no outlet, except such outlet as was gained by overflow from the depressions, when rainfall became excessive, and the other outlet is straight up, by evaporation, which is, of course, too slow an outlet to render the land of agricultural value.

A second type of river improvement found necessary for the reclamation of lands, can be studied in the Harrison-Monona Ditch, which differs so widely from the one just mentioned that it might well become the subject of an entirely independent study, were it not for the fact that the problems involved are so intimately related to the problems and the work of the first type of reclamation that it is deemed permissible and wise to discuss it in relation to the former. In this second case of the improvement of the Little Sioux River in Harrison and Monona Counties, the project costs nearly the same, one-half million of dollars. It is there planned to straighten the native channel of the river, until three times the original carrying capacity is secured. Parallel to this new river channel an immense ditch is being dug that, in places, is eighteen feet deep, 90 feet from berm to berm on top and 30 feet across the bottom. The capacity of this dug ditch is estimated at four times the original carrying capacity of the native river channel, making an increased power of run-off fully seven times that of the native stream. The object sought in this case is to provide free run-off for the waters, which formerly have flooded the low flats of the river valley. Those of you who have examined the flood plains of the tributaries running into the Missouri River from Western Iowa, have discovered that, in many cases, if possibly not in all, the river has built levees for itself until it meanders through alluvial soil of its own deposit at a level considerably higher, sometimes as much as four or five feet, than the level at the foot of the bluffs some miles away.

A third feature sought for in the drainage of these Iowa lands is the reclamation of swamp, bog and shallow lake. These are, again, a separate problem in drainage engineering and are frequently so treated. Yet, to the hydrographer, whom we, unfortunately, have not had on our drainage work, these lakes and bogs at once appeal as being intimately

related to the control of river flows and flood plain reclamation. Imagine observing from a balloon, Nature would show us an area, with many ponds and lakes, which catch and hold the rainfall within the water-shed. Only the overflow, and that which falls within the immediate water-shed of the river, contributes to the increase of river flood flow. In the times of the prairie, before the plow had broken the surface, rendering it more penetrable by the rain, floods were common, as evidenced by the deposits on the river flats and the meandering courses of these rivers. Deposits of soil eroded from the water-shed were, in these earlier days, comparatively small. Many of the rivers had clear water and pebbly bottoms. Since cultivation, conditions are so changed that more of the rainfall is absorbed directly by the soil. Floods have not been so frequent because the run-off is reduced, but those which do occur have been more destructive in their nature, carrying the loosened soil, to fill the channels and obstruct the flow, driving it out over the river flats.

The part played by these upland ponds and by the lakes, marshes and swamps, has been to catch and hold back much of the rainfall from causing floods in the river. Destructive floods, caused by rainfall alone, have been infrequent until within the past ten years, excepting within special sections. An illustration of these floods may be found in the year 1906. If dates are not mixed, the month of April was peculiarly dry. In May the rains early became excessive, lasting on until about the 10th of June. During the early part of May, it was frequently remarked by farmers and other observant men, that the ground took care of all the rainfall in excellent manner, the roads remaining good and drying rapidly within a few days. These conditions continued until the first week in June, when it was observed that ponds were beginning to fill, and the roads would no longer dry. During the first ten days of June, of almost continuous rainfall, all of the ponds and every depression rapidly filled to overflowing, and when, at last, one general rain came over the whole Des Moines River valley, these ponds, which were already filled to their utmost capacity, overflowed, flooding the river flat for miles in width, forest trees were drowned, bridges destroyed, crops inundated, heavy deposits of silt formed and everything growing was made profitless, except the late crop of hay, which practically formed after the flood. Let us still consider that we are in a balloon, watching the whole proceeding. Had we been able, with our fingers, to trace some channels to conduct water from these depressions to the main river channel, enabling them to carry, from the water-shed, excess waters and thus prevent the great accumulation which finally overloaded the whole river

to the flooding limit, this final disastrous flood, it is plain to be seen, could have been greatly reduced, if not entirely prevented. Then, again, had we been able to do this very thing, permitting the rapid escape of waters to the river, without any control, we might have produced floods of a no less serious nature, as will be observed from our former statement of how the final general rainfall brought flood. This sort of provision for rapid escape of waters, without any control, is what is being sought by the engineer in the construction of miles of open ditches in one drainage district, and hundreds of these drainage systems as extensions of one river system. If you are still with us in the balloon, at that time, observing the whole face of the Des Moines River water-shed, you would see that every lake and pond and depression was carrying its full capacity of waters; that the grounds themselves, had you dug into these soils in this area, you would have found carrying their full load of absorbed water. This suggests to us the necessity for the better control of these waters, than the mere construction of open ditches, to allow the escape of superfluous rainfall—some means by which the waters can be caught and held back and slowly fed to the river channels, enabling them to work continuously, with an even, regular flow of waters. Let us still consider that we are observing this area from a balloon. An engineer, at your side and mine, looking into the flooded channel of the Des Moines River, suggests, "We must straighten and deepen the channel of that river, enabling it to carry off these flood waters seven times faster than it now does. Then this flood would be prevented, these lands would be reclaimed and this loss would be stopped." This is what is being tried in Harrison and Monona counties, in that big ditch. At our side in the car of the balloon speaks up the forester friend, saying:

"But you must reforest large sections of the water-shed in the head waters of these rivers. Forest retards the run-off until it soaks into the soil, is given off in springs, feeding continuously and steadily into small streams, these, in turn, furnishing even feed for the main river channels, of clear, non-sediment-bearing water, and your troubles will be over."

The suggestions of our friend the forester are excellent, as viewed from directly above the lands, but when you stand on the ground, observing the value of each acre, its importance as a part of the food-bearing acreage of America. observing also that there is but little necessity, at any place, for trees to retard erosion of soils, the rare exception being the hill-sides and the gullies which are extended slightly out from the Des Moines main river channel, and in but very few places; the additional fact, growing out of this, that the slope of lands is insufficient to provide

a gravity outlet through the sub-soils into streams; the further fact that these streams do not exist, we are again thrown back upon the problem of creating an outlet for these waters and controlling them in their passage to the main river channels. The reclamation service engineer, whom we can imagine with us in the balloon car, hitherto silent, speaks up, with the suggestion:

"Save these waters and dam them in reservoirs, where they can be fed off to irrigate your lands in times of drouth, can be utilized for water power, with electric transmission, to control rapid transit, your manufacturing and your domestic needs."

Drop again to earth, where you can see things on the level, and search for valleys in the mountains, deep river channels, great lakes or canyons where waters can be stored. They cannot be found. There is truth in the suggestions of the reclamation service engineer, which may be worked out, but it is so remote as a practical possibility that it is out of the question at this period of industrial and agricultural development in this new section of our country.

If we can secure the desired result of storing and feeding the waters gradually to the river, we have overcome the flood, we have gained the point the forester urges, we have accomplished the desires of the drainage engineer, provided we do not need to overflow or submerge valuable lands in order to do this. It may be well, for a moment, while we are still on earth, to examine a few peculiar looking spots which we noted from the balloon car. This black splotch over in Kossuth County is the unexpected result of one drainage ditch, running into Kossuth County from Winnebago County. This drainage ditch cost \$86,000. Let me mention, in passing, that this \$86,000 is approximately one-five hundredth part of the total probable public drainage which will be constructed in the twenty-five or thirty counties. This big black splotch upon the landscape we find, on close inspection, to be a deposit of fine, rich, black alluvial soil, washed from the surface of some of the richest land in Iowa, into an open drainage ditch and carried to the outlet, which fortunately happened to be upon an ancient river terrace, permitting the sedimentation of the ditch water load upon the river flats. According to the engineer's and the county supervisors' estimates, 160 acres of land have been covered with material carried by this one drainage ditch, to a depth averaging two feet, since the completion of the ditch in June of 1908. Let us arise again in the balloon car and look at these thirty counties and imagine 350 such splotches upon the surface of thirty counties—more than ten to a county. Ten quarter sections of the richest of Iowa lands being carried away annually. Industrially, could we

endure the loss? Geographically, how long would it take to rob us of our richest heritage? Where these ditches run into rivers, the effects are not so readily observed, but they are none the less there. In one other region, where you look from our point of vantage over into the watershed of a neighboring river, you see an unusual flood following each more than ordinarily heavy rainfall, this flood covering but a short section of the river, measuring from head to mouth. Above and below, no floods. This strip of fifteen or twenty miles, being inundated after each heavy rain, is unfit for farming, but is dotted with excellent farm buildings and groves. The rest of the story, to explain, was told me by a legislator, at Des Moines, last winter:

"Five drainage ditches run into our little river within a short distance of each other. These drainage ditches are all open ditches and it seems that they have washed so much mud down into the river that the channel is choked for several miles. Now, every time a heavy rainfall comes, the lands below, for ten or fifteen miles, are flooded, whereas formerly, floods did not occur more frequently than once in fifteen or twenty years, and it was seldom then that these were destructive to crops. Now it is nearly impracticable to farm the lands in this section of the valley and my people are asking me to introduce a special bill to secure them relief."

Before we finally alight from the balloon, to study these problems more closely, we must admit that our friend, the reclamation service engineer, has suggested something of great value to us. In the reclamation project of Harrison and Monona Counties, the Little Sioux River does meet some of the conditions to which his plan will apply. Numerous V-shaped valleys, carrying at their bottoms small streams of clear water, help to make the system of the Little Sioux River much different from that of the Des Moines, the Iowa or the Cedar headwaters. These V-shaped valleys are of small value, agriculturally, and when broken by the plow wash readily into the streams, choking them and destroying their value for drainage purposes, making marsh and swamp lands of the once beautiful valley floor. The lands that would be lost by the construction of reservoirs to hold back the water rushing down in flood times to overflow the channels, would be comparatively small. A half-million dollar program, such as has been carried out in the Harrison-Monona Ditch, had it been expended in constructing dams, creating reservoirs and protecting river channels against flood waters and providing an equable flow of water in the river channel would have enabled the engineers to calculate definitely what channel conditions could be maintained, by a certain given water flow, which could easily be determined.

In other words, channel conditions cannot be maintained, except the flow of water can be placed under control and lastly, the expensive program of large channel construction would have been rendered very largely unnecessary, so that by the correction of the major crooks of the native channel, it would have been rendered capable of doing all the work required. The additional advantages of such a program of reclamation and river control, need not be discussed. The possibilities of water-power, so valuable now as a means of extension of rapid transit facilities, are evident. The possibility of irrigation of the flat lands of our river valleys by constructing irrigation laterals on the two or three river terraces are so obvious that our reclamation service engineer need not mention them to us. Who among you is not willing to admit for a moment that Iowa has not seen the time when irrigation would have benefitted much of her acreage? Who among you is willing to admit that Iowa soil is not capable of producing as valuable and profitable crops as any lands? Those of you who are familiar with the sub-soils of these river flats, are aware that they will readily lend themselves to irrigation; that they are seldom underlaid with impervious sub-soils and, in nearly every case, have gravels which render these soils peculiarly subject to crop loss in times of drouth, this same condition being most favorable for absorbing and using all waters applied by irrigation methods. Lands underlain by impervious sub-soils frequently require artificial under drainage in order for irrigation methods to work most successfully.

The tile drainage of these lands is being carried on at a rate per acre which will total when all lands needing it are well drained, about \$300,000,000. The effect which this tile drainage produces is to lower the ground water level to an average of about three feet or in wetter times 24 to 30 inches below the surface. This creates a porous soil cap which is capable of absorbing about 15 to 20 per cent of its bulk of water. This means that 30 inches of soil that is drained will absorb $4\frac{1}{2}$ inches of rainfall in about 48 hours without erosive run-off or leaving standing water in the depressions.

What this means in the solution of the problems given before can merely be suggested. But certain facts we know. There can be no better reservoir than a soil capable of absorbing this rainfall. We know by guaging of ground water level in drained lands that a rainfall is absorbed quickly and fed slowly off to the river through a period of many days and often weeks before the original low ground water level is again reached.

The remarkably heavy snowfall reported variously at from 64 to 84 inches in the Wisconsin Drift area, winter of 1909-1910, thawed in about

ten days since March 1st, 1910. The disappearance of snow was complete. The ground was but slightly frozen and practically all the water was absorbed. Another important fact the ground had been draining and the rivers had held at a reasonably high stage all winter. There was no trouble or danger at all from flood following the thaw of snow in March. These several phenomena present a very suggestive promise of what the result will be when the tile drainage is complete.

The peat marshes and the lakes may very safely be kept as reservoirs to help control the crest of floods, and it appears that the executive council has wisely been governed to deny many petitions which have come before it urging the drainage of meandered lakes.

PLEISTOCENE RECORD OF THE SIMPSON COLLEGE WELL.

BY JOHN L. TILTON.

The record briefly stated.

The record stated in detail.

The post-Kansan surface deposits.

The sub-loessial sand.

The Kansan drift.

The Aftonian deposits.

Gravel from the sub-Aftonian (Nebraskan) drift.

Carboniferous.

The water.

Discussion.

PLEISTOCENE RECORD OF THE SIMPSON COLLEGE WELL.

BY JOHN L. TILTON.

In the summer of 1907 a series of four wells were sunk within a radius of fifteen feet on the campus of Simpson College, giving the best record which it has been possible to obtain in the county. This record, made as the material was removed, is here presented in detail. It serves as a typical record down to the Aftonian, beyond which the deposits described are not commonly reported within the county. The surface of the well is at 970 feet, A. T.

The record briefly stated.

2 ft. Soil, black (loess and humus).

28 ft. Loess yellow above, blue below; then blue clay (gumbo, a modified loess); then a grayish blue sandy loess; no effervescence.

2 ft. Sand, yellowish and gray. Sub-loessial.

54 ft. Clay, with pebbles, boulders and lime concretions; yellowish brown for one foot, then grayish blue for seventeen feet, then bluish black for thirty-six feet. Kansan.

25 ft. Deposit, black, with old soil plains and minute partings of vegetation, but no wood, and almost no pebbles.

1 ft. Pebbles from sub-Aftonian (Nebraskan) drift.

112 ft. (Ends on the Carboniferous).

The record stated in detail.

THE POST-KANSAN SURFACE DEPOSITS—30 FEET.

2 ft. Soil, a black loam (loess and humus.)

28 feet. A brownish loam for ten feet, porous, a mixture of clay and microscopic particles of quartz, streaked with brown oxide of iron in root-like tubes and with very thin layers of a dark brownish sand; entirely free from pebbles. At thirteen feet from the surface the deposit is less clayey than above and contains more numerous streaks of brownish sand. Two feet deeper (at 15 ft.) the deposit is slightly bluish; then for two feet it is grayish and more dense; then for three feet is a dense blue clay free from sand and impervious to water, but still free from effervescence and free from pebbles. (The ground water, the surface of which was encountered at eight feet, rests on the impervious clay at this level.) For the next eight feet (to 26 ft.) the clay is of a light grayish blue, still free from pebbles and effervescence. At first (at 21 ft.) it is somewhat more gritty than above and contains traces of a brown oxide of iron. The first four feet of the eight caved badly, large water-soaked masses (wet from below upward) scaling in vertical sheets from the sides of the well, as the uppermost phase of the loess does by the roadside.

The first pebble encountered was a small angular red granite at twenty-six feet, dimensions 5-16x3-16x2-16 of an inch. In the next two feet (to 28 ft.) the deposit (the lower loess) contains a fine sand and spherical grains of quartz 1-16 of an inch in diameter. The remaining four feet to the sand (sub-loessial) is grayish in color and with a grayish and brown sand through it. In the bottom of this deposit was a pebble 3-8x2-8x1-8 of an inch, and grains of quartz up to 1-8 of an inch in diameter.

THE SUB-LOESSIAL SAND.—2 FEET.

Sand, pure, brown and gray. At the well to the east this sand is almost wanting. At the well farthwest west the sand is nearly four feet thick. At the intermediate wells it is about two feet thick, the bottom of the sand sloping to the west.

KANSAN DRIFT.—54 FEET.

Directly beneath the sub-loessial sand is a light brownish blue stiff clay in which the first concretion of calcium carbonate was found, and two small pebbles of greenstone, then a bowlder too large to get into the auger, and, at 33 feet, a dark blue clay with the first distinct effervescence of the clay itself, this effervescence continuing with each auger full for fifty-

three feet till the bottom of the Kansan had been reached at a depth of 86 feet. Here at 33 feet were also found a rounded quartz and a sub-angular limestone pebble.

From 33 feet to 49 feet the clay varied from a brownish clay to a light bluish clay and then to a grayish blue, with brown sand and gravel scattered through it, and with pebbles and bowlders. At 47 feet the surface of this grayish blue clay was of a darker shade; at 48 feet there were patches of a dark blue clay 2x1 3-4x1 inch, grading outward into a lighter blue clay, thus forming pieces of a dark blue clay surrounded by zones of the gray clay weathered in from the streaks of sand, the darker blue clay containing pebbles and scattered grains of sand, thus resembling in all respects except color the grayish blue clay and bluish gray clay above. In the next foot the pieces of dark blue were larger, the gray lying in distinct planes between the masses of dark blue.

From 50 to 86 feet, the bottom of the clay that effervesced, the blue clay was dense, bluish black and dry (the unoxidized and unhydrated portion of the Kansan) with a fine brown sand in little pockets half an inch or so in diameter and with thin irregular bands similar to those along which the blue in the upper two feet is weathered into the irregular masses. There were numerous pebbles, lime concretions and fragments of wood.

THE AFTONIAN.—25 FEET.

Beginning with 87 feet a part of the clay does not effervesce. In the next foot the effervescence is still less, and in the third foot (the 89th) the last lime concretion, one inch in diameter, appears. The clay is on the whole a dark grayish blue, but grades back and forth from black to light blue. Minute root-like fragments of vegetation are scattered through it, but no fragment of wood was found. At 95 feet is a layer of moss and black dirt about an inch thick; a foot deeper is a similar layer. In these old soils were a few small pebbles of greenstone, black chert, quartz and limestone, to the last of which the slight effervescence seemed to be due. The largest greenstone pebble was 1-2x1-2x1-4 inch; the fragments of limestone were 1-2x5-16x5-16 inch and 1x2x3-8x1-4 inch. In the next foot (97) there is another layer 1 1-2 inches thick of this old black soil and moss, and in the next foot two inches more like an impure peat. Between these two layers was an angular fragment of limestone 1x5-8x3-8 inch. In the next nine feet (to 106 feet) there were no pebbles and the grit was very fine, the largest particle being a particle of greenstone 1-16 of an inch in diameter at 106 feet.

At 107 feet from the surface the grayish blue clay contained traces of a brownish sand, the largest grain of which was a greenstone 1-8x1-8x1-16 inch. A foot deeper (at 108 feet) several sub-angular pebbles of greenstone were encountered, one, the largest, 3-4x1-2x3-8 inch; another 1-2x3-8x1-8 inch; another 3-4x1-2x3-8 inch and sub-angular in shape. For the next two feet (108 and 109) the dark grayish clay was streaked with brown sand and contained minute pebbles, the largest of which was a chert 3-8x5-16x1-2 inch. The next half foot was a grayish clay with streaks of brown sand, and with gravel at its base. Within the next few inches came a bed of gravel, described as follows:

GRAVEL FROM SUB-AFTONIAN (NEBRASKAN) DRIFT—1 FOOT.

The gravel was coarse above, fine below, with half inch streak of bright red clay in the midst of it.

The greenstone of the gravel were rounded and sub-angular, all smooth and unweathered, four striated, one especially flat and striated, on one side, rounded on the other and pitted in three places, the edges and solid angles rounded and polished—a typical glacial pebble. One limestone fragment contained part of a shell like a fragment of *Productus muricatus*, the index fossil of the Des Moines formation.

The complete analysis of this gravel is as follows, all excepting the very finest material being used in making the analysis:

ANALYSIS OF GRAVEL FOUND AT THE BASE OF THE AFTONIAN
(GRAVEL FROM SUB-AFTONIAN DRIFT)

Limestone, gray, many angular, one with a fragment like *Productus muricatus*, the index fossil of the Des Moines formation. This is all to be classed as local material, and is possibly derived from the very stratum on which the gravel rests.....

the gravel rests.....	63	18.4	0
Greenstone, four striated, many rounded and sub-angular.	148	44.1	57.4
Sandstone, gray (local)	15	4.4	0
Sandstone (not local)	6	1.8	2.3
Granite, all but four light colored.....	29	8.6	11.3
Quartz	33	9.8	12.8
Chert, brown	15	4.4	5.9
Chert, dark	5	1.5	1.9
Chert, light	4	1.2	1.5
Quartzite, pink	2	.6	.8
Quartzite, dark	3	.9	1.1
Quartzite, light	7	2.1	2.7
Schistose rocks	6	1.8	2.3
	336	99.6	100.

In the above table the first column of figures expresses the exact number of pebbles found; the second, the percentages of all the pebbles; and the third, the percentages of the foreign material only.

If in the above that which is local in character be excluded, all the remainder are of a very resistant character, not a single specimen being found of the decomposed granite so common at the surface of the Kansan drift. The largest of the granites has a rough surface such as may be found in a granite of similar texture scaling under the action of frost. The almost complete absence of pink quartzites is also a notable fact when comparing the analysis with analyses of pebbles from the Kansan.

The sizes of the largest pebbles are as follows:

Limestone—

4 $x1\frac{3}{4}x1\frac{3}{4}$ inches.
 3 $\frac{3}{4}x3x2$ inches.
 3 $\frac{1}{2}x2x1\frac{1}{2}$ inches.
 3 $x1\frac{1}{2}x1\frac{1}{2}$ inches.
 3 $\frac{1}{4}x1\frac{3}{4}x1\frac{1}{4}$ inches.
 2 $x1\frac{1}{2}x1$ inches.

Granite—

3 $\frac{1}{2}x3x1\frac{3}{4}$ inches.
 3 $\frac{1}{2}x3\frac{1}{4}x2$ inches.
 3 $x2\frac{1}{4}x2$ inches.
 2 $\frac{3}{4}x1\frac{3}{4}x2$ inches.
 2 $\frac{1}{2}x2x1\frac{1}{2}$ inches.
 2 $\frac{3}{4}x1\frac{1}{4}x1\frac{1}{2}$ inches.

Pink Quartzite—

1 $\frac{1}{4}x1\frac{1}{4}x\frac{3}{4}$ inches.

Greenstone—

4 $\frac{1}{2}x3x2$ inches.
 3 $x3x\frac{5}{8}$ inches.
 3 $x2\frac{1}{4}x1\frac{3}{8}$ inches.
 3 $\frac{1}{4}x3\frac{1}{2}x2\frac{1}{2}$ inches.
 2 $\frac{1}{2}x2x1\frac{1}{4}$ inches.
 2 $\frac{3}{4}x1\frac{3}{4}x1$ inches.

Quartz—

4 $x2\frac{1}{2}x1\frac{5}{8}$ inches.
 3 $x2\frac{3}{8}x1\frac{1}{2}$ inches.
 1 $\frac{1}{4}x1\frac{1}{4}x1$ inches.
 1 $\frac{1}{2}x1x\frac{5}{8}$ inches.
 1 $x\frac{7}{8}x\frac{3}{4}$ inches.
 1 $\frac{1}{4}x\frac{3}{4}x\frac{3}{4}$ inches.

CARBONIFEROUS.

The bottom of the well is on a hard flat rock, which is undoubtedly a carboniferous stratum in place, and presumably the source of many of the limestone pebbles found in the gravel.

WATER.

The character of the water obtained through the gravel bears evidence of the presence of partially decomposed vegetation (Aftonian). The water is so charged with free ammonia that the quantity of this ammonia was not determined. The albumenoid ammonia present was found to be thirty-two hundredths of a part per million.*

*The analysis was made by Professor C. J. Holmes.

DISCUSSION.

In the above description the material down to the weathered surface of the Kansan is what is commonly found throughout the uplands in the central part of the county. Parts of it correspond to what has been described in other places where the Kansan is the surface drift.

From the top of this drift, at thirty-two feet, down to the bottom of the drift at eighty-six feet the characteristics of the deposit are so like those of the Kansan drift, and the gradations so perfect from a weathered portion to an unweathered portion below, that there seems no possibility whatever that it includes more than one drift sheet. It is therefore all classed as Kansan.

The deposit that underlies the Kansan is peculiar. The color of the deposit and the presence of a few pebbles within the twenty-five feet, though the pebbles are only about half an inch in diameter, suggest sub-Aftonian drift; but the appearance of stratification, marked especially by the distinct layers of moss with accompanying black dirt, at least four of which were conspicuous, are not characteristics of drift at all, but of a non-glacial deposit into which it seems possible such small pebbles may have been washed, though I noted no stratum of gravel associated with them within the deposit. Such a deposit, between a Kansan above a sheet of gravel below that contains glacial pebbles, is classed as a part of the Aftonian interglacial deposit. The deposit appears to be a unit, though varying slightly close to the gravel at its base.

The stratum of gravel with glacial pebbles at the bottom of the well must have come from a glacial deposit antedating the Aftonian. It was therefore derived from the sub-Aftonian (Nebraskan) drift, for no other drift sheet is known from which it may have come. The conditions suggest that the well reaches the bottom of a ravine into which gravel from sub-Aftonian drift was washed.

The sub-Aftonian drift is wanting at this particular place, unless a trace of it is left immediately beneath the streak of bright red clay. It is not wanting in various parts of the county. The Kansan may be seen in its usual aspects in the higher ground, while along the deeply cut trenches in ravines may be seen the dense, bluish black sub-Aftonian, largely free from boulders and pebbles. The soil washed from the hill-sides generally covers the dividing surface between the two drifts and whatever of Kansan may remain.

MAXWELL COULEE AND THE DIVERSION OF THE RIO MORA.

BY CHARLES R. KEYES.

(*Abstract.*)

Maxwell Cone or Bald Mountain is a low eminence rising out of the plain at the south foot of the Turkey mountains, in northeastern New Mexico. The last mentioned mountains form a rather conspicuous circular ridge of high hills having an even crest. These mountains are situated about 30 miles northeast of Las Vegas and about 20 miles east of the Rocky mountain front. The vast even plains stretching out to the eastward of the Rockies in this region is a part of the Las Vegas plateau.

Maxwell mound is a typical ash-cone. It rises scarcely 400 feet above the general level of the plains. As viewed from the railway train six miles away, and against the high Turkey range, it is quite inconspicuous. The crater is perhaps 1,000 feet across, and on the southern side is breached. Through this breach extends a notable flow of basalt. Near the volcano the flow is five to six miles broad; and for a distance of 8 miles it retains this width, when it abruptly becomes narrower as it enters the canyon of the Rio Mora. It continues down the Mora canyon to its junction with that of the Rio Cimarron, a distance of 30 miles.

The lower end of the basalt flow was early noted by Stevenson.* The crater was incidentally visited by LeConte, Newberry and Hayden. The lava-stream has been passed over on the cars by many geologists on their way to the Southwest. Between Tipton and Shoemaker stations, a half hour's ride from Las Vegas, the Atchison, Topeka and Santa Fe railroad traverses the great flow for a distance of several miles. From the train a fine view of the breached crater is obtained to the northwest; and to the southeast the flow may be easily followed with the eye until it disappears into the Rio Mora canyon.

Two especially instructive features present themselves in this connection. One point is the diversion of the Rio Mora itself by the lava-flow; and the other is the amount of stream-corrasion which has been accomplished since the basalt first occupied the canyon.

*American Jour. Sci., (3), Vol. XXI, p. 154, 1881.

The channel of the Rio Mora has been pushed to one side of its former course by the lava having filled the old canyon and a new canyon has been formed in the massive Cretaceous sandstone of the neighborhood. This diversion of the river is in many places very marked.

The amount of erosion which has taken place is admirably shown in a number of places. The present canyon of the Mora river is in places over 1,000 feet deep. The bottom of the old canyon at the time of the flow of lava was at level about 250 feet higher than the bottom of the channel today. The basalt-stream is about 400 feet in thickness. Above its upper surface it is still 500 feet more to the edge of the plain forming the general surface of the country. Since the time the lava flowed the Rio Mora has been not only forced to corrade an entirely new channel, but it has eroded its new canyon 250 feet deeper than its old one.

DISTRIBUTION OF BONANZAS IN THE PACHUCA SILVER DISTRICT OF MEXICO.

BY CHARLES R. KEYES.

(*Abstract.*)

There is one feature of mining that has long been of especial interest. It is the distribution of the particularly rich ore mass or bonanza. In a recent visit to the celebrated silver mines of Pachuca, Mexico, unusual opportunity was offered me to carefully examine into some of the most instructive phases of this subject. The facts obtained throw light upon many vexed problems connected with many abandoned silver mines of our own country, still certainly containing large amounts of easily available ores.

The Pachuca and Real del Monte mining districts lie in the Sierra de Pachuca about 60 miles northeast of the City of Mexico. The rocks composing the mountain range are mainly Tertiary andesites, rhyolites and basalts, the first mentioned type being the oldest and containing the principal ore-bodies. These silver mines are among the most famous in the world. Geologically they are of great interest on account of the large number of very rich ore-bodies which have been opened up in them—by the Mexicans termed “bonanzas.”

The ores are disposed chiefly in east and west lodes which are in the main nearly parallel to one another and have about 75 degrees to the southward. The gangue is principally quartz; and quartz-reefs form conspicuous ridges on the surface of the ground. In this quartz the silver in the sulphide form is disseminated in a finely divided state.

Much has been made of the observation that in the parallel systems of veins the bonanzas of contiguous lodes alternate; that is, the richest parts of one vein are opposite the lean portions of the adjoining one. I know of no published explanation of this phenomenon. In my own examination of the mines and of the geologic structures of the country about I was greatly impressed with the significance of a series of great joint-planes, or faults, which traverse the mountain range nearly parallel with its axis and at an angle with the trend of the lodes. I am inclined to associate the localization of the bonanzas with the intersections of the fault-planes with the mineral veins. As the faults cut the latter at a

wide angle the alternate occurrence of the bonanzas would be the natural arrangement. A careful study of the relationships of bonanzas to geologic structures would doubtless yield practical results of the highest importance in the future exploration of the district.

The vertical grouping of the bonanzas into distinct upper and lower zones, as is generally recognized by the miners of the district, I do not attach much importance to. Any such arrangement, if it actually exists, must be manifestly accidental in that it cannot be dependent upon geologic structure. Singularly enough, however, such lodes as the Cristo for example displayed bonanzas only in the upper portions. On the other hand the Santa Gertrudis, Vizcaina and others presented them only in the depths. A few veins, as the Corteza and Analco are reported to have contained bonanzas in both upper and lower zones.

In this connection it may be of interest to note that a single bonanza in the San Rafael mine yielded more than \$15,000,000. This rich body was 3,000 feet long, 1,200 feet deep, and from 5 to 10 feet in thickness.

THEORY OF METEORITIC AGGLOMERATION AND THE ULTIMATE SOURCE OF THE ORES.

BY CHARLES R. KEYES.

At the present time unusual interest is taken by mining men in the subject of the origin of the deposits of the metallic ores, the extent of the world's supply, and the means of conserving them, for alarming as it may seem the end is already in sight.

Localization of ore-materials, or their formation into workable ore-bodies is now generally ascribed to the agency of waters circulating in accordance with well established geological laws and under peculiar geologic conditions. The circulatory currents may move through the deeper zones of the lithosphere below groundwater level, through the upper or vadose zone, or on the surface of the ground. In each zone there is a distinctive series of mineral concentrations.

The ultimate source of ore materials has been heretofore usually considered on the theory of a cooling terrestrial globe, according to the scheme imposed by the nebular hypothesis. The metals are thus assumed to reach the surface of the earth from a heated and perhaps metallic interior. There is another possible derivation of the metallic materials of the ores. Although the hypothesis has received since its proposal the support of distinguished authorities, from ore students it has not attracted the attention that it seems to deserve.

On the hypothesis of the origin of the planetary and stellar bodies through meteoritic agglomeration, as proposed by Meyer,* metallic substances in a fine state of division must be constantly falling upon the earth's surface. That portion of the stellar dust which falls upon the land and areas mingles immediately, almost unnoticed, with the soil; and finally enters into the rocks which some geologists consider as the flotsam drifting upon the heavy centrosphere. That part which falls into the sea goes to form the characteristic bottom-muds of the ocean. Whether falling on land or water the stellar-dust particles, on account of their high specific gravity and their prevailingly metallic nature, tend sooner or later to sink deeper and deeper beneath the lighter rock material on

*Beitrag zur Mechanik des Himmels, p. 157, 1848.

which from space they drop. Local conditions at or near the surface of the earth may reverse the usual direction of this migration so as to bring together the metallic materials into ore-bodies.

As aptly noted by Stallo, the general doctrine of meteoric agglomeration is in effect nothing more than a new statement of the law of parsimony, which forbids the unnecessary multiplication of explanatory elements and agencies. Exemplification of the logical principle has long been afforded by the various branches of science, and conspicuously by the new geology. The past history of the earth is accounted for in terms of what is continually going on around us. At no stage of the earth's record does genetic geology attempt to call into action forces other than those which are now at work changing the existing features of our globe.

In its main features Meyer's theory of meteoritic agglomeration is essentially identical with the planetesimal hypothesis of earth origin as recently and specifically set forth by Chamberlin.* Upon ultimate analysis, the meteoritic hypothesis is not so wholly novel and so radically distinct from the nebular hypothesis of Laplace as some of its advocates would have us believe. G. H. Darwin† has shown that the meteoric swarm is dynamically analogous to a gas; and in reality the laws of gases strictly apply to it.

At the present time the planetesimal hypothesis has especial attraction in its bearing upon the ultimate origin of the ores. It explains satisfactorily many phases of ore-genesis which have long remained enigmatical. It does away with the sweeping claim that ores owe their formation entirely to volcanic activities; and it suggests the vadose zone as the seat of the principal segregation of ore materials generally.

The meteoritic augmentation to the earth seems to be very much larger than it was once supposed to be. Something of the larger meteoric irons and stones has long been known; and our prevailing notions of extra-terrestrial materials are mainly confined to these occurrences. It is, however the constant and almost inappreciable shower of cosmic dust and particles falling upon the earth's surface that is of greatest consequence as a possible source of ore-supply.

The magnitude and persistency of the stellar dust shower ordinarily escapes notice. It is rendered visible in various ways. Hailstones are frequently found containing small particles of presumably meteoric iron. By the melting of snow in the arctic regions fine metallic particles composed mainly of iron, nickel, cobalt, etc., are obtained.

*Carnegie Institute Yearbook, No. 3, p. 208, 1905.

†Philos. Trans. Royal Soc. London, Vol. CLXXX, pp. 1-69, 1889.

The banded appearance of arctic glaciers is well known. Its main cause seems to be layers of fine dust and minute rock-fragments. Nordenskiöld,* in particular, calls attention to the banded appearance of certain arctic snow-fields in which the dark zones were found to be due to minute black grains, most of which were found to be due to minute black grains, many of which were metallic in character. Chamberlin,† in presenting some fine photographic views of the fronts of Bryant, Krakokla and other Greenland glaciers, specially emphasizes the conspicuous banded appearance. While he incidentally states that the dark particles are "mainly terrestrial," he gives no data upon which he bases his conclusion; and he leaves it to be inferred that he regards at least a part of the material as perhaps meteoric in character. The myriads of dust-wells which the same author‡ describes in the surface of the great Igloodahomyne glacier seem to have like significance.

The great abundance of chondres in the abysmal deposits which cover the floor of the ocean is especially noted by Murray and Renard¹ in the reports of the Challenger expedition. These masses are largely composed of basic minerals, closely related to the earthly substance known as bronzite; and, with small doubt, appear to be of cosmic origin.

Some conception of the reality and importance of the heavenly swarm which is constantly reaching us may be gained when it is remembered how frequent and numerous are meteoric falls. In each 24 hours there are, according to Young² no less than from 15,000,000 to 20,000,000 of meteorites entering the earth's atmosphere.

The frequency of meteoric irons and meteoric stones in the arid regions of the globe, and especially on the high dry plateaus, is particularly significant in this connection. While such falls are probably not more common in those districts than elsewhere, the peculiar climatic conditions tend to give them prominence. The clear air, the cloudless skies, and the high altitudes contrast sharply with the thick atmosphere and prevailingly cloud-covered firmament of the sea coast of humid lands. In the high, dry regions, the frequency of meteoric manifestations immediately arouses the wonder of the sojourner from cloudy countries. The constant stream of light-paths across the heavens reminds one, every night in the year, of the November meteoric showers of other parts of the world.

*Voyage of the Vega, p. 18.

†Journal of Geology, Vol. III, p. 568, 1895.

‡Ibid., p. 215.

¹Narrative Cruise H. M. S. Challenger, Vol. II, p. 809, 1885.

²Astronomy, p. 472.

Moreover, a dry climate appears to prevent rapid rock-decay. There is practically no such phenomenon as chemical decomposition of the rocks as it is known in the moister regions of the globe. The breaking down of rock-masses near the surface takes place mainly by means of insolation, which is strictly mechanical disintegration. Meteoric irons remain for years upon the surface of the desert without notable oxidation.

Again, the meteorites in such regions, instead of being immediately lost to view in vegetation, covered by soil, and subject to rapid chemical decay, as in humid countries, are left exposed on the surface of the ground through the constant removal by the winds of the lighter soils.* This cause affects, of course, all the larger rock-fragments, of whatever origin. The pebble mosaics which cover large tracts of arid plain, described by Blake,[†] by Tolman,[‡] and by me,^{||} amply attest the extent of this remarkable phenomenon.

For peculiar reasons, meteoric masses are not easily recognizable in the pebble pavements. The majority of desert rocks are susceptible to notable discoloration and wind-polishing, which imparts to them a burnt and fused appearance. Travelers in the desert are prone to ascribe this characteristic of the rocks to volcanic action; and it is invariably one of the features of such regions which at once attracts their attention. For example, in describing the general impressions gained in crossing the broad desert tract in New Mexico known as the Jornada del Muerto. Wallace[§] says, "the portion I speak of appears to have served its time, worn out, been dispeopled and forgotten; the grass is low and mossy, with a perishing look—the shrubs, soap-weed, and bony cactus writhing like some grisly skeleton; the very stones are like the scoria of a furnace." Until they are broken in two the darkened rock-fragments give little suggestion of their real lithologic character.

The more basic rock-masses and larger rock-fragments which strew the ground throughout the arid regions are almost invariably coated by a black iron and manganese film which, highly polished by the wind-blown sands and dusts, gives every appearance of fusion. The aspect thus produced is not unlike that of the fused surface of meteorites falling in moist lands. Among such dark lacquered rock-fragments, it is with greatest difficulty that true meteorites can be distinguished. That they do occur abundantly nevertheless, is well shown by the rock-collections displayed at every cattle ranch.

Bull. Geol. Soc. America, Vol. XIX, p. 73, 1908.

[†]Trans. American Inst. Mining Eng., Vol. XXXIV. p. 161, 1904.

[‡]Journal of Geology, Vol XVII, p. 149, 1909.

^{||}Ibid, p. 74.

[§]Land of the Pueblos, p. 140, 1888.

A notable instance of the exceptional frequency of meteoric irons in desert regions and one which has recently attracted wide attention from scientists, is that of the Canyon Diablo falls in eastern Arizona, first brought to notice by Foote.* Twenty miles east of that isolated and majestic pile of volcanics known as the San Francisco mountains and rising abruptly out of the vast even plain forming the general surface of the high plateau, is a low mound locally called Coon Butte. The center of this low elevation is occupied by a crater-like depression about 1,000 feet across. In the vicinity of this hill such large amounts of meteoric iron have been collected from time to time as to give rise to the fantastic notion that the crater was produced by an enormous meteorite striking the earth at this point,† the impact causing the fragments to be scattered about in all directions. As a matter of fact meteoric irons are no more abundant around Coon Butte than they are in other parts of the dry country, or probably in the desert tracts of the globe generally. At Coon Butte, a large company has been led into expending thousands of dollars in sinking shafts and in drilling for the supposed heavenly iron-body deeply buried in the bowels of the earth. The central depression itself is to all appearances a true volcanic crater of the explosive type;‡ but the accidental finding of many pieces of meteoric iron within it and about it has stimulated the imagination of observers, who have given undue weight to these occurrences as indicative of the origin of the crater. The occurrence of such meteorites instead of being special and novel, is general and wide-spread in desert regions. It is to these arid tracts of the globe that we must look for the greatest extension of our knowledge concerning meteoritic materials.

It is to the desert regions likewise that we must turn for information regarding the character of the rain of stellar dust. The remarkable prevalency of black-sand grains in the desert soils has generally escaped the notice of travelers. On the vast high plains of the dry Mexican plateau, metallic particles occur abundantly in soil, miles away from the mountains and from outcrops of igneous rocks. The plains are so level, the distances from the mountains so great, and the rain-fall so scanty as to preclude the easy transportation of these heavy particles by means of water; while their high specific gravity must prevent their movement by means of the winds. Yet after the severe rain-showers which occur at rare intervals, when little rills traverse the surface in all directions, considerable quantities of the "iron-sands" accumulate along the paths of

*American Jour. Sci., (3), Vol. XLI, p. 413, 1891.

†Smithsonian Misc. Coll., Vol. L, p. 461, 1908.

‡Bull. Geol. Soc. America, Vol. XVIII, p. 721, 1907.

the moving waters. A thorough chemical investigation of the composition of these sands would be highly instructive. The common black sands of placers appear to be in the main totally distinct; and their origin is usually traceable to decomposing igneous rocks. The metallic sand-particles of the desert soils necessarily long resist decay. Should these particles prove to be of meteoric origin, the fact would tend to make such estimates of the annual meteoric augmentation to the earth's volume as those given by Chamberlin and Salisbury* ridiculously inadequate. As it is their figures must be vastly too low.

The petrologic features of meteorites present many suggestive relationships to those of the igneous rocks of our globe. Among the common terrestrial rock of igneous origin there are usually recognized four main groups: the acidic, the neutral, the basic, and the ultra-basic. Among earth-rocks those of the last mentioned class are quite rare; but in the case of stony meteorites the rock species distinguished are very largely ultra-basic. Some of these mineralogic aggregates correspond, it is true, to some of the most basic of the terrestrial series; but the cosmical series begins with the earthly basic class and continues through the ultra-basic, of which limbergite and peridotite are the chief terrestrial examples, to yet unnamed series in which the metals form a larger and larger proportion.

So long ago as 1871, Meunier† recognized among the meteorites no less than 50 distinct lithologic types, most of which he later‡ described the microscopical characters and reported in them a wide range of metallic elements.

Among the metals occurring in meteorites are all of those found in the common ores. Gold and silver are the only conspicuous metals which do not yet appear to be found abundantly in meteorites. There are, however, good reasons why these two metals have not been reported more frequently; and other reasons why certain other metals seemingly occur only sparingly; so that the apparent absence of these elements in the composition of known meteorites does not preclude their derivation from this source.

As is well known, the relative abundance of chemical elements appears to be different in the terrestrial and siderial rocks. It is suggested by Farrington,|| however, that there is very good reason for believing this difference to be apparent rather than real. Only the crust of the earth

*Geology, Vol. I, p. 381, 1905.

†Geologie des Meteorites: Moniteur scientifique Quesneville, Feb. 1-15, 1871.

‡Bull. de la soc. d'hist. nat. d'Autun, t. XVI, 1893; also t. XVIII, 1895.

||Journal of Geology, Vol IX, p. 394, 1901.

is considered; and the analysis of meteoric material does not often show the true proportion of stony matter.

The introduction of meteoritic materials into rock-masses and their incorporation into ore-bodies are not intricate processes. On the theory of meteoritic agglomeration the original and often the immediate source of ore materials cannot be in nature so largely magmatic as it is vadose. Qualified in some ways and strengthened in others, the general arguments of Forchhammer, Sandberger, Winslow, Van Hise, and Bain assume a new interest and an added value. The main shortcoming, if such it really be, is merely in ascribing a sole, or principal, origin of the ore materials to rock-weathering, when a somewhat broader interpretation of the facts seems necessary.

It is not difficult to fancy the manner in which metallic substances of meteoritic origin may become incorporated with ore materials generally. After reaching the surface of the earth, both cosmic dust and the larger meteorites must mingle with the soil, more or less quickly oxydize, and enter by means of circulating groundwaters or otherwise, the deep-seated zone, in the same way as any of the heavier mineral particles liberated from the surface rocks through decomposition are supposed to do. The processes involved are essentially the same as for the changes and movements of rock-forming ore-materials. The distinction to be made is that instead of the ore material being derived from the breaking down of the rocks of the lithosphere; a very large proportion comes from extra-terrestrial sources.

Although there is probably no such universal sea of groundwater as that pictured by Van Hise, there is yet no reason for not believing that surface waters readily penetrate to the deep region, even to the zone of rock-flowage. The lithosphere thus represents merely the flotsam and jetsam of the globe through which the heavier materials may migrate, generally inward as individual particles, but occasionally or spasmodically outward, in connection with volcanic outbreaks.

In the course of the inward migration of ore materials temporary ore-bodies are often localized in the vadose zone chiefly. How much of these materials are of the recent extra-terrestrial origin and what proportion is the product of the rock-decay, is at present difficult to estimate. The meteoritic contribution has yet received insufficient attention. That it may be much more important than has been suspected hitherto is clearly shown by recent observations in desert regions. That this is the main source of vadose ore-materials now seems not unlikely. It is probable that

most of the diffused metallic content of the sedimentary rocks is in reality immediately derived from meteoritic sources; for its derivation from the country rock of mining districts, especially in tracts far removed from volcanic activity has never been a very satisfactory explanation.

THE AFTONIAN AGE OF THE AFTONIAN MAMMALIAN FAUNA

BY SAMUEL CALVIN.

The publication of the paper on the Aftonian Mammalian Fauna, in the *Bulletin of the Geological Society of America*, volume XX, pages 341-356, has very naturally elicited a number of questions which, however, bear chiefly on two points: First, are we certain as to the precise age of the gravels? and, second, are we certain that the mammalian remains described may not be older than the Aftonian? Two papers prepared by Professor Shimek and published in the *Bulletin of the Geological Society of America*, volumes XX and XXI set out the evidence bearing on the first of the questions; it will be sufficient here to consider the second. The first mammalian bones which came into my hands from the Aftonian were few in number and small in size. As to age there were just two possibilities, as there are but two with respect to any and all the fossil remains found in the gravels. The animals represented were either contemporary with the deposition of the gravels—or practically so—or they lived in preglacial time. They certainly did not live during the interval of pre-Kansan glaciation. The bones that first came to hand were assumed to be preglacial because that seemed best to accord with the state of knowledge at the time relative to the age and genesis of the gravels. On that assumption their history could be easily sketched. They had been imbedded and preserved in some preglacial deposit; they had been separated from the original deposit by washing or weathering, or the gouging action of glacial ice; they had been picked up by the pre-Kansan glaciers and incorporated in the sub-Aftonian drift; they had been washed out of the drift in Aftonian time and carried by Aftonian streams to be eventually laid down as part of the assorted Aftonian gravel. This assumption tallied very well with what certainly was the history of a number of other fossils taken at the same time from the gravels. These include parts of the dentary bone with broken teeth of *Clidastes*, two fragments of guards of belemnites, and an internal cast of one of the air chambers of *Placentiaceras*, all from Upper Cretaceous horizons; there is also a left valve of a narrow *Gryphaea* which may be Jurassic; and there is a fragment of a corallum of *Favosites* from the Niagara.

Now the question is pertinent: If *Clidastes* and *Favosites* and these other things represent pre-Aftonian faunas, why may not all the fossils be older than the gravels in which they are imbedded? The fossils themselves furnish the answer. All the pre-Aftonian types, even those that are completely silicified, are very much battered and worn; they are mere weathered and abraded fragments retaining nothing of the beauty and freshness of corresponding fossils taken from their original matrix, and they occur in very limited numbers. On the other hand the fossils referred to the Aftonian occur in far greater numbers than could be expected in accordance with any reasonable probability if they have been washed out of the pre-Kansan drift. If they are pre-Aftonian they must have come out of the drift, for the Boyer, the Soldier, the Maple and the other streams along whose valleys the fossil-bearing gravels occur, have no access to any preglacial surface anywhere. Their valleys are excavated in drift. The bones and teeth would have to be very plentiful in the drift if the drift has furnished all we find in the gravels, but there is no record of the finding of any mammalian remains in the pre-Kansan.

A very large proportion of the Aftonian fossils are not abraded or worn in even the slightest degree. They are fresh and perfect as a *Placenticeras* taken directly from concretions in the Pierre shales around the Black Hills. Some are broken, as would be expected, but many that would be liable to breakage under hard usage are perfect. The imperial jaw represented in figure 1, plate 25, of the Bulletin paper, would not travel very far as part of a ground moraine. The tibia, figure 5 of the same plate, is not marred or scratched; the same is true of the great tooth and the cervical vertebra, figures 7 and 8. The specimens shown in figures 2, 4 and 6 are broken, but the fractures are fresh and there are no signs of abrasion. The fine mastodon tooth above 7 is absolutely perfect so far as signs of wear or weathering are concerned. A few small chips are broken from some of the cups, but the fracture surfaces are as recent in appearance as if the breaking had been done in taking the tooth from the pit. There is practically no wear showing on any of the material represented in the plates of the published paper, and there is much more equally as perfect. The contrast between this material and that which is known certainly to be pre-Aftonian is very striking.

It is but just to say that there is in the collection a considerable amount of fragmental material that shows the effects of weathering and abrasion, but it is exactly what would be expected of animal re-

mains exposed for some time to atmospheric weathering and subsequently transported by energetic gravel-bearing streams.

Another point in favor of the Aftonian, rather than a pre-Aftonian age for the fossils is that some of the finds indicate that the bones had been floated into place while yet some of the ligaments were intact and the skeleton was not completely dismembered. The teeth of *Mastodon mirificus*, plate 27, were taken from a well, and in the limited space covered by the bottom of the well the workmen found the two upper molars, parts of the tusks, a large amount of cranial bones and other bones of the skeleton, that could not, by any conceivable probability have been there if the specimen had gone through the vicissitudes experienced by the pre-Aftonian fossils. A more convincing case is that of the complete tusk of the American mastodon, unbroken, unmarred, eight feet in length around the curve and eight inches in diameter at the larger end, taken from Aftonian gravels penetrated in digging a well near Mapleton. With the tusk were found one upper tooth, a large amount of the cranium, bones of the legs and others, showing that a considerable portion of the skeleton has been deposited while yet the bones were held together. The pieces of the cranial bones show the socket for the tusk and sockets for the fangs of the teeth. The proximal end of the ulna is among the material taken from the well. The bottom of the well could cover only a small part of the space where the skeleton lay. Most of the breakage was evidently due to the well diggers. The Gladwin horse, plate 17, affords another illustration of the same kind. A full set of upper and lower molars were found, lying in their natural relations to each other; with quite a large number of bones properly related, but too soft to be preserved except for some fragments of the lower jaw. The chances that the true relations of so many parts of the skeleton could have been maintained through all the movements and processes to which they would have been subjected before reaching the position in which they were found, in the case of a horse that lived and died in preglacial time, are so few as to be negligible.

The phalanx of *Mylodon*, plate 26, had the claw sheath almost complete when found. During the life of the animal this sheath was exceedingly vascular to afford nourishment to the horny nail or claw proper. After death the nail quickly decayed and left the sheath unsupported when, owing to the great number of vascular channels, it became exceedingly fragile. The specimen can hardly be handled without breaking off some of the sheath. Had this animal lived in preglacial time and been preserved in preglacial deposits, no part of

this delicately fragile sheath could have survived the mechanical attrition which necessarily would have attended its removal by glacial ice and swollen streams to the place where it was found. The horny part of the claw decays rapidly. Bears' claws buried with Indians which inhabited Iowa since the coming of the white man have this horny part completely decayed. It is safe, therefore, to infer that if our *Mylodon* were preglacial, the claw proper would have disappeared by natural process of decay long before the advent of the pre-Kansan ice, and we should have to believe that the specimen, in essentially its present condition, had been transported by at least two energetic and none too gentle agents without injury to the fragile sheath. Even if the glaciers had treated the specimen ever so tenderly, a very short journey in gravel laden streams would have obliterated every vestige of the very vascular bone that covered the root of the horny claw. In this case, as in most of the others, a pre-glacial age for the animals represented by the fossil bones is simply unthinkable.

Another point must not be overlooked. If the fossils under consideration had been incorporated in the pre-Kansan drift as would certainly have been the case with many of them if they are of preglacial age, the larger pieces could never have found their way into the Aftonian gravels retaining anything like their present state of perfection. A large bone or an entire tusk would not be washed out of the tough glacial clays all at once. An end or a side would be exposed long before the whole specimen could be completely freed and this, affected by corrosion and weathering, would crumble into small fragments; the process of waste would keep pace with the rate of removal of the covering till, little, if anything, would be left to be transported and deposited by Aftonian streams. But there is no need of multiplying arguments; the improbability of these fossils being pre-Aftonian will be recognized and acknowledged by any one who has seen the material and knows the conditions under which it was found.

CONCERNING A STUDY OF KEROSENE OILS BY PHYSICAL METHODS.

BY G. W. STEWART.

Kerosene oil has been the subject of investigation for a number of years, and with the result of improved processes in refining and an illuminant which fulfills a definite need quite satisfactorily. But these investigations have been conducted almost wholly from the point of view of the chemist. This is really not surprising when the complex character of the oils and the necessarily very complex character of the chemical changes in the burning flame are considered. To secure any practical results by physical methods seems at first sight to be hopeless, for does not the illuminating power of the oils depend upon the constituents, and how is it possible to obtain any information save by means of a knowledge of these compounds? Yet the investigations concerning which this note is presented have given definite results, and assure us that a further investigation along physical lines is highly desirable.

My object in this account is to give some of the results without a detailed description of the experiments. The work will be published with sufficient details in the near future.

The first problem attacked was the "illuminating power" of the oils. It should be stated at the outset that the variations in illuminating power in the kerosene oils found on the market are not sufficient to make the subject of illuminating power the most important field of investigation. Such a study is, however, one of the most difficult. (The maximum variation in the oils studied is 17 per cent). One of the first precautions observed was to secure a method of comparing the illuminating power of the different samples under the same conditions. The conditions include the lamp, the wick, the size of the flame, the barometric pressure, the humidity, etc. The variation in the conditions of the atmosphere was eliminated by the use of a comparison sample. Whenever tests were made, observations were taken upon the sample used as a standard of comparison, and all results reduced to the same basis.

It is not my desire to discuss here the methods by which the variations in the other conditions were eliminated. Suffice it to say that it was possible to make tests of illuminating power that were actually comparative.

For the sake of accuracy it should be stated that "illuminating power" as used in this paper refers to the candle-power-hours-per-gram, the measurements of candle-power being made in one direction only, that direction being perpendicular to the plane of the flams. It was found that the illuminating power of the samples as received did not seem to have any definite connection with any usual tests such as residue, density, and viscosity. Of course no relation could be anticipated as to the fire and flash tests, and none were found. It is impossible to conceive of any relation between the illuminating power and density and viscosity, yet the results of these experiments do show a definite relation, though not a simple one.

The illuminating power of samples obtained by the distillation of a good grade of kerosene oil was measured, and it was found that these distillates showed a definite relation between illuminating power and density. The former gradually increases with the latter, the actual change in illuminating power being 3 per cent between the densities 0.78 and 0.83. There was also found a definite relation between viscosity and density. The fact that such a relation should exist in the distillates of one sample of oil and yet not occur in the various samples of oil taken in the market, is most significant. It was this fact that led finally to a method of comparison of the various samples of oil which showed a definite result.

The method of procedure in this comparison will be explained without giving the train of reasoning involved. A curve was plotted showing the relation between viscosity and density in the case of the distillates of the one sample of oil. This curve was assumed to represent the ideal conditions. The viscosities of the tested samples were then compared with the viscosities as shown by the curve for oils of the given densities. The ratio between the so-called "ideal" viscosity and the actual viscosity was thus obtained. (Where viscosity is used, reference is made to the coefficient of viscosity.) A curve was now plotted with illuminating power as ordinates and this ratio as abscissae. The result, astonishing as it may seem, is that with 28 out of 30 samples tried, the curve showed a definite relation. That is to say, if this curve can be assumed to represent the oils correctly, the illuminating power of an oil should be measured quite closely by measuring its viscosity and its density. This result suggests the possibility of testing an illum-

inating oil without burning it and presents a most interesting relation between the illuminating power and the physical tests of the oils. In the 28 samples the average variation of the illuminating power from that shown by the curve is 1.3 per cent. When it is remembered that measurements of candle-power within one per cent requires very good facilities, the accuracy of the curve becomes more remarkable.

Having given this very striking result, the question very naturally arises as to the correctness of the curve. The majority of the oils tested were from samples of oils sold in North Dakota, but three of them were obtained from independent refineries in Pennsylvania, Ohio and Kansas, and 13 of them we obtained on the market in the states of Minnesota, Illinois, Iowa and South Dakota. Although the experiments do not demonstrate the limitations of the application of this curve, yet it is not expected that the results can be applied to oils coming from fields which are widely different. In fact, the agreement obtained in these experiments is very surprising. It is fair to say that the writer does not lay much stress upon the numerical results obtained in this investigation. In his opinion, the greatest value of these experiments is that they demonstrate beyond a doubt that there are possibilities in a study by physical methods which have not been appreciated heretofore.

SOME RECENT DISCOVERIES CONCERNING THE BEHAVIOR OF PLATINUM-IRIDIUM WIRES.

BY L. P. SIEG.

The remarkable elastic properties of a certain platinum-iridium wire containing 40 per cent of iridium were first announced by Guthe¹. In his experiments the wire was used as the suspension of a torsion pendulum. Although the amplitudes of vibration were less than 50 degrees, a marked increase both in the period and in the logarithmic decrement accompanied the increase in the amplitude. Cylinders of equal mass but of different moments of inertia were suspended from the wire, set in vibration, and timed, but as a result of these experiments no change was observed in the logarithmic decrement-amplitude curves. This absence of any effect led to the supposition that the damping was proportional to the amplitude, and independent of the velocity.

The study of the elastic properties of such wires was continued by Guthe and the writer² during the latter part of 1908 and the early part of 1909. In that work, wires containing different percentages of iridium were used. The apparatus was so constructed that much larger amplitudes could be obtained than were obtainable before. As a result of the use of the larger amplitudes, additional information concerning the relation of period and of logarithmic decrement to the amplitude were obtained. It was found that although both the period and the logarithmic decrement varied directly with the amplitude for small values of the amplitude, they did not continue to do so for larger values of amplitude. The periods at these large amplitudes tended to become constant, and at the same time the logarithmic decrements reached a maximum, and then diminished. The peculiarities in the elastic behavior of these wires were found to increase as the percentage of iridium was increased.

This present paper represents only one of two interesting facts concerning the action of a 40 per cent platinum-iridium wire, which facts have developed from observations on the wire taken during the present year. To make the conditions perfectly clear it will be necessary to

1.—K. E. Guthe, *Proc. Iowa Acad. Sci.* 15, p. 147, 1908; *Abs. in Phys. Rev.* 26, p. 201, 1908.

first give a brief description of the apparatus used and of the method of timing. The apparatus was the same described in one of the former papers². The torsional pendulum was supported from a firm brace bolted to the wall. The mirror attached to the suspended weight was exactly in the center of a complete circular scale, the diameter of the scale being 149.2 cms. This large diameter gave a space of 2.6 cms. to a degree, and so enabled one to read with accuracy to tenths and to estimate in the smaller amplitudes to one one-hundredths of a degree. The scale was of course really divided into double-degrees, because a twist of one degree of the mirror would give a displacement.

of two degrees of the spot of light on the scale. The amplitudes of the vibrations were read by focusing the image of a wire, illuminated by an arc light, on the above described circular scale. It was possible by the use of the complete circle for a scale and the double mirror, to read all the amplitudes with the exception of a very few when the mirror was end on. This equipment was a decided improvement over that used in the preceding experiments, for in those some of the important amplitudes were obtained only by interpolation. The method of fastening the wire to the supports, and of attaching the various moments of inertia was the same as that described in the former paper. To the upper rod holding the wire was attached a torsion head, graduated into degrees, and having adjustable stops. This device made it possible to set the wire into vibration, and to hold it at practically constant amplitude. The method of timing was, with only one or two changes, essentially the same as that explained in the former paper. In all cases, unless otherwise stated, the periods are in reality half-periods. To make perfectly clear how the periods were obtained, the method will be briefly described. A drum geared to a motor running at nearly constant speed wound tape from a roll, drawing it under a pen attached to the armature of an electro-magnet. A Bond and Son's sidereal break-circuit chronometer in circuit with the electro-magnet gave double-second marks on the tape. Connected with the recorder by a separate circuit was a tap key, which was closed at the ends of each vibration. The periods were obtained by end readings instead of by center readings, in order to have periods match the corresponding amplitudes, these latter being of course measured at the ends of the vibrations. There were then recorded on the same tape the times at which the turning points were reached, and also the double-second marks. When the amplitude had decreased to a value of from 15 to 20 degrees, the tape was abandoned, and the periods thereafter were obtained by the method of coinci-

2.—K. E. Guthe and L. P. Sieg, Phys. Rev. 30, 1910.

dences. Upon the tape record, the chronometer times of the turning points were recorded in hours, minutes, seconds and hundredths of a second. Supposing that t is this recorded time for the 5th vibration, and that t' is the time for the 25th vibration, then $t'-t$ is the time elapsed between these two vibrations. This difference divided by 20 is used as the period of vibration of the mean swing; in this case, the 15th. In this way the errors arising from individual observations are diminished; and while this method is not an exact one, numerous tests have shown that it gives essentially correct values. A sample of one of the curves connecting period and vibration number is given in Fig. 1. The figure shows how well the observed values fit a smooth curve, and how in most cases it was unnecessary to correct the period readings.

To see if there was any variation in the relation between amplitude and period; this variation, if any, being possibly due to the magnitude of the initial amplitude, the following experiments were performed. The wire was annealed at dull red heat by a current of 2.5 amperes, for about 30 seconds. Care was taken not to allow the wire to vibrate through more than 15 or 20 degrees after this treatment. The wire was then carefully twisted through a certain small amplitude and timed by the method described above. After a rest of a day the wire was twisted through a larger amplitude and timed as before. This was continued with constantly increasing initial amplitudes until at the sixth observation the total amplitude of swing had reached a value of 788 degrees. This was an amplitude from the zero position of 394 degrees, and a twist per centimeter of length of the wire of 9.8 degrees. The results of this set of experiments are given in table 1, and graphically shown in Fig. 2.

TABLE I.

Length, 40.2 cms. Moment of inertia, 980 g. cm².

No.	Amp.	Period	No.	Amp.	Period	No.	Amp.	Period
0	28.1	5.149	0	74.5	5.198	0	102.0	5.300
10	26.6	.147	15	62.2	.192	10	83.0	.287
20	25.1	.145	25	55.0	.186	30	52.8	.262
30	23.6	.144	35	49.0	.183	40	42.6	.250
40	22.4	.142	50	41.3	.178	50	34.2	.238
50	21.2	.141	70	33.3	.171	60	28.3	.228
70	19.2	.139	90	27.3	.165	70	23.8	.218
90	17.4	.138	120	21.3	.158	80	19.8	.208
110	16.2	.136	150	17.0	.153	90	16.8	.200
130	15.0	.135	180	13.5	.149	110	12.1	.188
150	14.0	.135	200	12.0	.147	130	10.0	.180
170	13.2	.134	210	11.3	.145	140	8.9	.175
190	12.4	.133	230	10.3	.143	160	7.3	.167
210	11.8	.133	240	9.8	.143	180	6.2	.161
230	-----	.132	250	9.4	.142	200	5.3	.157
300	9.2	.131	300	7.6	.140	230	4.4	.155
350	8.2	.130	350	6.3	.138	250	3.9	.154
400	7.4	.129	400	5.4	.135	350	2.6	.150
450	6.9	.129	450	4.7	.133	400	2.3	.148
973	3.31	.128	874	2.35	.133	450	2.1	.147

0	190.0	5.508	0	308.0	5.820	0	738.0	5.986
10	135.0	.498	5	249.0	.813	5	619.0	.986
20	91.0	.468	10	195.0	.795	10	517.0	.986
30	58.2	.427	15	150.0	.771	15	426.0	.986
40	36.3	.364	20	109.0	.730	20	344.0	.985
50	24.8	.312	25	78.0	.676	25	270.0	.972
60	17.3	.274	30	53.0	.601	30	206.0	.946
70	13.3	.249	35	37.0	.520	35	150.0	.905
90	8.6	.226	40	27.0	.435	40	104.0	.847
110	6.0	.212	45	20.0	.390	50	46.0	.673
130	4.6	.201	50	16.0	.365	60	22.0	.515
150	3.7	.193	60	10.0	.326	65	17.0	.465
160	3.4	.191	70	7.0	.300	70	13.0	.425
170	3.1	.189	80	6.0	.271	80	9.0	.383
180	2.8	.187	90	4.80	.250	90	6.1	.362
200	2.5	.184	100	4.1	.234	100	5.0	.340
220	2.2	.182	120	3.08	.227	120	3.7	.300
240	2.1	.180	140	2.4	.222	140	2.75	.280
250	2.0	.178	160	2.09	.216	160	2.1	.265
300	1.6	.172	170	1.98	.214	210	1.4	.259

It will be seen that for small initial amplitudes the wire is in its behavior not far different from ordinary wires, i. e., its change in period with amplitude is small, but it will be seen also that as the initial amplitude increases, the periods corresponding to a given amplitude increase in a remarkable manner. Not only does the period increase, but so also does the internal friction, as is evident when we examine the total number of vibrations necessary to bring the wire down to a certain small amplitude, say 5 degrees. This number will be noted in table 2. In the column headed "O°" is the first obtained reading for

TABLE 2.

	O°	T	Vibration to 5°
Nov. 30-----	14.1	3270	625
Dec. 1-----	37.3	2190	425
Dec. 2-----	51.0	1093	210
Dec. 3-----	95.0	664	125
Dec. 4-----	154.0	484	88
Dec. 5-----	369.0	567	100

the maximum amplitude from the rest point. In column headed "t" is the number of seconds which elapsed while the pendulum fell from 0° to 5°. In the last column headed "Vibrations to 5°" are in each case the number of vibrations that occurred while the torsion pendulum was coming down from the given initial amplitude to an amplitude of 5 degrees. It is quite evident then that as the initial amplitude is gradually increased the wire seems gradually to change its elastic condition. The remarkable fact, however, is that the elasticity of this wire when determined by a static method has been found to be practically constant. There is not space in this paper to describe the experiments on the static determination of the elasticity of the wire.

A better insight into the frictional losses in the wire, following these different experiments is obtained from an examination of the variations in the logarithmic decrement with the amplitude. These decrements have been calculated for the above set of experiments, and although the logarithmic decrement here loses its original significance,

it is still very instructive as to the information it gives as to the damping. The following values for the decrement (cf. tables 3 and 4) were

TABLE 3.

Length, 40.2 cms. Moment of inertia, 980 g. cm².

M-N	Am.	An.	Log. Am.	Log. An.	Log. Am.-An.	Log. Dec.	Mean Amp.
4 ----	639	526	2.8055	2.7210	.0845	.0211	582
4 ----	582	476	.7649	.6776	.0873	.0218	526
4 ----	526	427	.7210	.6304	.0906	.0227	476
4 ----	476	381	.6776	.5809	.0967	.0242	427
4 ----	427	337	.6304	.5276	.1028	.0257	381
4 ----	381	295	.5809	.4698	.1111	.0278	337
4 ----	295	220	.4698	.3424	.1274	.0319	256
4 ----	220	158	.3424	.1987	.1437	.0359	188
4 ----	158	110	.1987	.0414	.1573	.0393	132
4* ----	110	75	.0414	1.8751	.1663	.0416	90.7
4 ----	75	53	1.8751	.7243	.1508	.0377	62.3
8 ----	62.3	33.8	.7945	.5289	.2656	.0332	44.4
11 ----	53.2	26.3	.7259	.4200	.3059	.0278	38.4
14 ----	44.4	21.9	.6474	.3404	.3070	.0219	33.8
17 ----	38.4	19.3	.5843	.2856	.2987	.0176	26.3
20 ----	33.8	16.9	.5289	.2279	.3010	.0151	21.9
20 ----	16.9	12.3	.2279	.0899	.1380	.0069	14.2
20 ----	12.3	10.1	.0899	.0043	.0856	.0043	11.1
40 ----	10.1	8.0	.0043	0.9031	.1012	.0025	9.0
145 ----	8.0	4.54	0.9031	.6571	.2460	.0017	5.82
159 ----	4.54	3.21	.6571	.5065	.1506	.0009	3.80

TABLE 4.

Mean Amp.	Log. Dec.	Mean Amp.	Log. Dec.	Mean Amp.	Log. Dec.
18.2	.00072	46.1	.00208	59.3	.00403
17.8	98	43.8	218	54.1	393
17.4	100	41.7	219	49.4	386
17.0	102	39.7	208	45.4	354
16.6	105	37.7	219	41.9	342
16.3	80	35.9	205	39.0	313
16.0	81	33.8	216	36.3	287
15.7	84	32.6	213	34.0	268
15.3	85	31.1	195	28.5	233
15.0	86	27.8	195	24.0	198
14.7	88	23.4	176	20.3	165
13.3	80	20.4	212	13.0	109
11.5	66	18.1	150	6.72	060
7.95	72	14.4	174	3.88	044
6.08	53	10.7	119	-----	-----
5.00	45	7.83	106	-----	-----
4.26	50	5.57	088	-----	-----
3.72	41	-----	-----	-----	-----
3.27	41	-----	-----	-----	-----

115	.00944	194	.0196	400	.0193
103	950	177	203	366	199
92.4	942	161	202	333	209
82.9	953	147	207	302	216
74.2	958	133	220	273	227
66.5	944	120	226	245	240
59.7	944	96.7	239	194	262
53.5	930	77.7	240	150	304
43.3	919	62.2	237	112	331
35.2	887	50.1	228	82	366
28.9	824	41.0	205	59.2	334
24.1	756	34.3	186	45.9	313
20.5	656	27.5	150	32.6	296
17.7	590	21.7	112	25.6	245
13.7	502	14.7	0646	21.0	186
11.2	386	12.4	0324	14.0	118
7.2	132	9.8	0387	9.45	069
5.33	95	7.6	0172	6.76	0458
3.64	119	6.2	0181	4.59	0262
		4.19	0081	3.31	0156

calculated from observations similar to those described above. To save space only one complete table is given, and for the other six experiments, are recorded merely the finally calculated decrements and the corresponding amplitudes. In all cases common logarithms are used. The results of these tables are graphically shown in Fig. 3, where curves are drawn corresponding to the gradually increasing initial amplitudes.

Another set of experiments similar to that mentioned in the preceding section was tried, the difference between the two being that in this case the wire was started at the large amplitude at first, and then successively started at the lower amplitudes. It was thought that this would settle the question as to whether the period depends merely upon the amplitude, or whether, in a more complicated fashion, it depends to a large extent upon the preceding history of the wire. The latter was found to be true, and the results for the amplitude-period relations are shown in table 5 (a)-Fig. 4, and for the amplitude-loga-

TABLE 5-(a).

Length, 40.2 cms. Moment of inertia, 980 g. cm².

No.	Amp.	Period	No.	Amp.	Period	No.	Amp.	Period
0	477	5.958	0	151	5.905	0	108	5.825
2	437	.958	4	117	.860	4	81	.810
4	398	.958	10	74	.773	10	48.3	.690
6	361	.957	16	43	.660	14	33.3	.604
8	326	.953	20	30	.580	16	27.9	.562
15	219	.925	24	21	.485	20	19.9	.485
24	113	.820	28	16.2	.415	26	13.3	.387
30	64	.678	35	11.4	.345	30	10.9	.350
34	43	.595	45	8.1	.297	36	8.7	.314
40	26	.475	55	6.4	.267	40	7.8	.297
55	13	.330	65	5.4	.253	50	6.1	.263
65	10	.290	75	5.0	.247	55	5.5	.253
80	7	.255	85	4.4	.244	60	5.1	.245
85	6.7	.248	95	4.0	.240	80	4.2	.240
100	5.7	.236	100	3.8	.239	100	3.4	.236
101	5.55	.236	121	3.23	.231	136	2.52	.231
179	3.06	.231	174	2.47	.225	190	2.01	.222
237	2.39	.227	232	2.02	.224	244	1.67	.222
301	1.92	.219	299	1.64	.222	303	1.41	.222
370	1.57	.216	371	1.38	.222	362	1.22	.222

No.	Amp.	Period	No.	Amp.	Period
0	73.3	5.765	0	20.7	5.425
10	30.0	.580	6	14.0	.375
12	21.4	.509	10	11.4	.348
20	13.9	.403	14	9.6	.320
26	10.2	.342	16	8.6	.308
30	8.7	.315	20	7.8	.292
36	7.2	.289	24	6.9	.280
40	6.4	.277	26	6.6	.275
50	5.2	.256	30	6.1	.265
55	4.8	.250	35	5.4	.257
60	4.4	.245	40	5.0	.250
70	3.9	.241	45	4.6	.245
80	3.4	.239	50	4.3	.240
90	3.2	.236	60	3.8	.235
100	3.0	.235	70	3.4	.238
115	2.8	.232	80	3.2	.232
125	2.7	.230	90	3.0	.230
135	2.6	.228	100	2.8	.228
142	2.62	.225	157	2.01	.222
238	1.49	.222	220	1.66	.222

rithmic decrement relations in table 6-Fig. 5. In table 5 (b) are results corresponding to those in table 2 for the preceding set of experiments. A comparison of the two tables [Tables 2 and 5 (b)] will clearly bring out the essential differences between these two sets of experiments.

TABLE 5-(b).

	O°	T	Vibrations to 5°
Dec. 7.....	239	620	114
Dec. 9.....	75.5	407	75
Dec. 10.....	54	335	63
Dec. 11.....	36.7	286	52
Dec. 12.....	10.4	212	40

TABLE 6.

Amp.	Log. Dec.	Amp.	Log. Dec.	Amp.	Log. Dec.	Amp.	Log. Dec.	Amp.	Log. Dec.
437	.0197	143	.0260	94	.0312	62.3	.0367	17.9	.0293
398	.208	126	.295	69	.363	43.4	.400	14.0	.246
361	.214	110	.298	48.3	.398	30.0	.351	11.4	.209
326	.227	95	.346	33.3	.397	19.9	.371	9.6	.169
271	.247	81	.352	23.3	.367	13.2	.251	8.1	.144
219	.274	62	.383	17.1	.307	10.2	.181	6.8	.107
175	.309	52	.397	13.3	.242	8.7	.148	5.4	.083
133	.350	43	.430	10.0	.175	7.4	.136	4.6	.065
94	.377	35	.391	8.7	.135	6.4	.109	3.6	.042
78	.417	21	.335	7.1	.110	5.0	.0749	3.0	.029
43	.394	16.2	.241	6.1	.0933	3.9	.0560	2.4	.023
26	.302	11.4	.177	5.1	.0540	3.1	.0241	1.84	.013
19	.222	8.1	.125	2.52	.0291	2.75	.0158		
13	.1505	6.4	.0881	1.84	.0149	2.6	.0077		
10	.1054	5.2	.0494	1.54	.0125	2.09	.0026		
8	.0870	4.7	.0464	1.32	.0106				
6.5	.0589	3.8	.0373						
6.1	.0511	3.6	.0357						
2.16	.0149	2.9	.0220						
1.75	.0127	1.51	.0104						

Since the points in Figs. 4 and 5 lie so closely together, only through those for the largest initial amplitudes are curves drawn. However, the loci corresponding to the different initial amplitudes are indicated on the two figures, and the general relations of their paths can readily be seen.

In the progress of the last year's work many other interesting phenomena concerning the wire have been observed, and the full results of the work have been published in a more technical journal¹. However it was thought that the above observations would be of interest to the members of the Academy, and of value to students of physics.

¹L. P. Sieg, Phys. Rev. 31, Oct., 1910, p. 421.

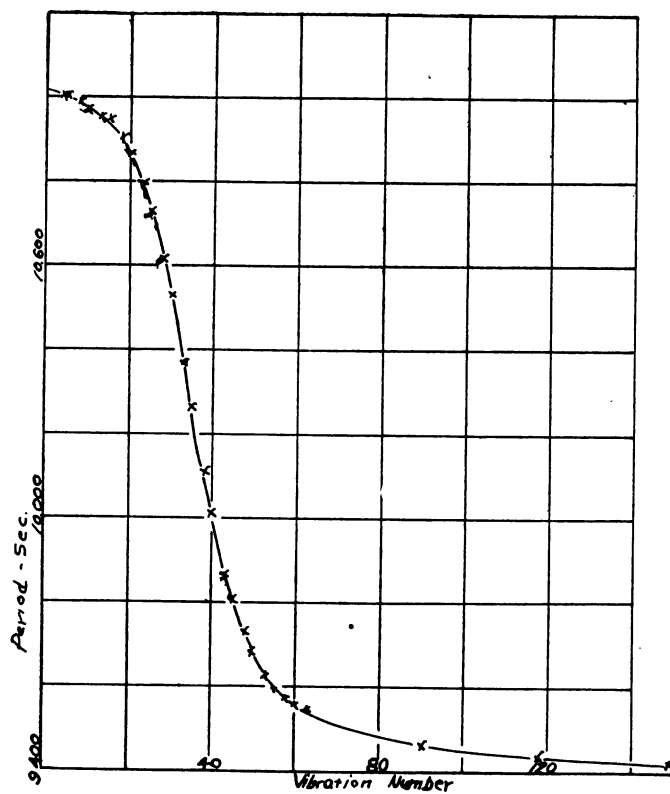


FIG. 1.

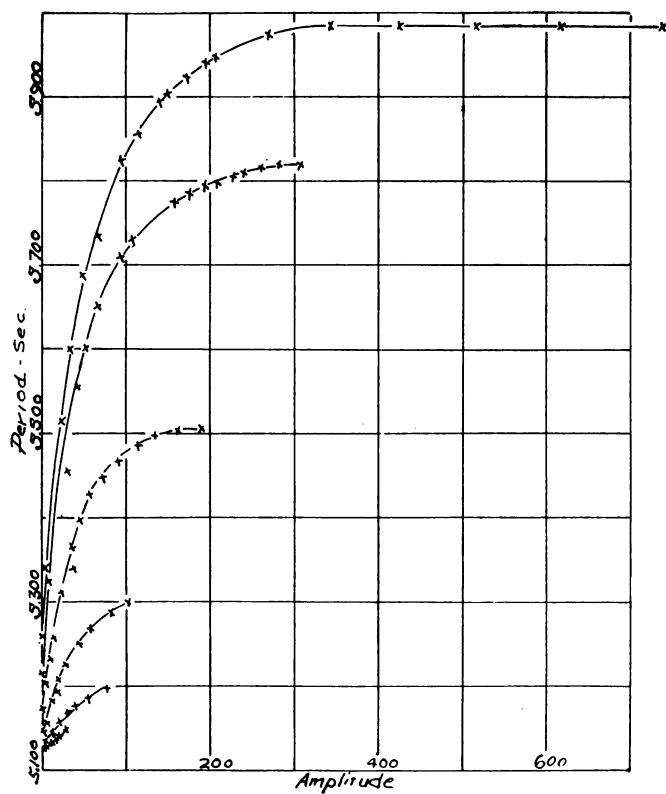


FIG. 2.

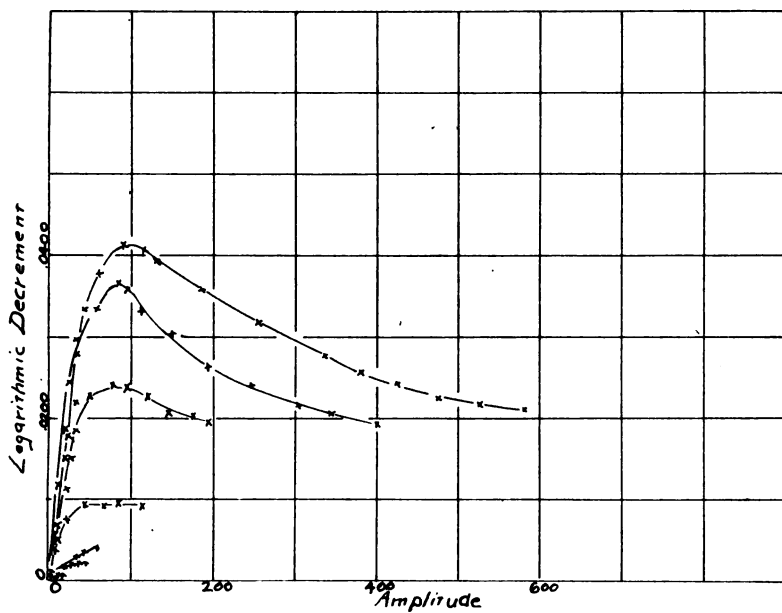


FIG. 3.

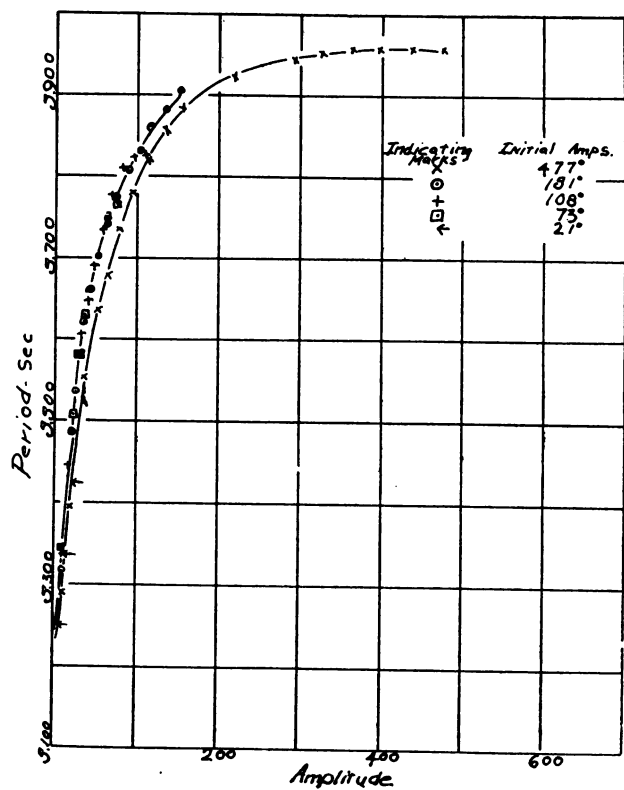
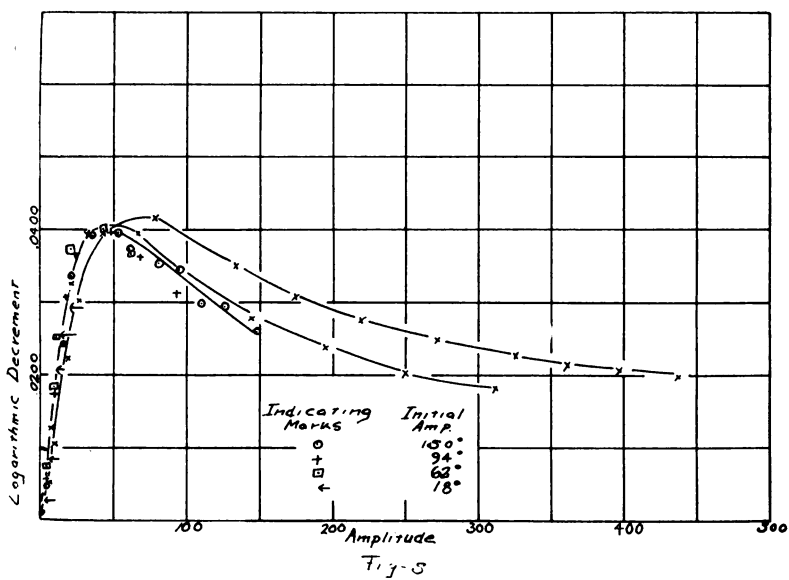


FIG. 4.



SOME STANDARDIZING TESTS OF STERN'S TONE VARIATOR.

BY R. H. SYLVESTER.

The tone variator is a closed-tube sound producing instrument. It consists of a cylindrical brass bottle, the bottom of which is a piston controlled by a delicate cog-wheel mechanism. By means of this the depth of the bottle may be readily changed, thus varying the pitch. The sound is produced by a stream of air directed across the mouth of the bottle through a tube set at the proper angle. A pointer attached to the piston's setting gear indicates the pitch in terms of vibrations per second.

The purpose of this study was to determine the reliability of the instrument and how best to manipulate it. It seemed especially well suited for investigations in pitch discriminations. Stern, the inventor of the variator, in an article in Vol. XXX of *Zeitschrift fur Psychologie*, gives a full description of it and a good general estimate of its practical value. In our conclusions we have not overlooked his estimates, but we have drawn every conclusion directly from records made by the variator itself.

The arrangement of apparatus finally hit upon is as follows: The stream of air is furnished by Whipple tanks. Their pressure is regulated by weights and by a screw clamp applied to the soft rubber carrying tube. A water manometer attached to this tube gives the pressure readings. For reading the pitch of the tone emitted, the tonoscope is used, with a phonette for its receiving apparatus. This apparatus, though quite complicated, is easily managed by one operator, and pitches to a small fraction of a vibration are read accurately.

The variator was first tested as to its behavior under different pressures of the air stream. An increase of pressure causes a rise in pitch. This variation is greatest for light pressure. Thus, an average rise of 6.79 vd. resulted from changing the pressure from 2 units to 3 units, while there was but 2.84 vd. rise when the pressure was increased from 3 units to 4 units. (A unit is one-fourth of the highest pressure that will produce a sound in the variator.) The variation with pres-

sure is greater for the higher pitches. For a pressure increase of from 2 units to 3 units, the rise in pitch was as follows:

Pitch	Rise
200.....	5.69
250	5.79
300.....	6.37
350.....	7.79
400.....	9.08

The variator is most reliable at the lowest pressure which will cause it to sound. The mean variation at 3 units pressure was 0.70, while at 1.5 units pressure it was only 0.29. The low pressure gives a pure, steady tone, quite free from any pinched or hissing quality.

A similar study was made of the effect of changing the position of the mouth-piece. Raising the mouth-piece above the level of the top of the bottle lowers the pitch. This is greater when the mouth-piece is already in a high position than when it is low. Thus, a change in gap of 3 mm. to 4.3 mm. lowered the pitch as much as a change from 0 to 3 mm. Again, a change in gap from 1.95 mm. to 3.90 mm. caused a rise of 4.80 vd., while a change from 0 to 1.95 mm. gave a rise of only 2.33 vd. The greatest change in pitch that can be made by changing the position of the mouth-piece is about 10 vibrations. The best position for the mouth-piece is the highest that will produce a tone. Set at 0. the results showed a mean variation of 0.6; at 3 mm. gap, a mean variation of 0.4; and at 4.3 mm. gap, a mean variation of but 0.1. There is a most favorable mouth-piece position for each pitch, the higher tones requiring a narrower gap. The wider gap requires a stronger pressure. It is also worthy of note that the 200 vd. to 400 vd. size of variator is most reliable at between 250 vd. and 270 vd.

The manner in which the instrument's mouth-piece is attached is very unsatisfactory. It should be absolutely firm, accurately adjustable, and provided with a setting scale showing the width of the gap. The piston sometimes settles downward. It must be fitted with a clamping device. At the lowest pressures, some tones which give no audible sound, produce a clear reading in the tonoscope. Such tones must be started by the operator's blowing into the variator and starting the general air movement required. The securing of a steady air stream is a serious problem. As noted earlier, the slightest pressure change causes a considerable change in pitch. The Whipple tanks are perhaps the best contrivance, but they demand very close care, and are at best a frequent source of error.

As to the real value of the variator, it can be relied upon only as an instrument of approximate pitch and relative intervals. The fact that its pitch varies with pressure and mouth-piece position, and probably with temperature, humidity, and other conditions makes an absolute reading scale impossible. A variation in one of these conditions would throw any scale out of proportion. But even if it cannot be relied upon for careful quantitative work, it is a desirable piece of apparatus for the psychology laboratory. Its loud clear tone and ready manner of changing pitch make it especially valuable for general class experiments and tests.

CONTRIBUTIONS TO THE HERPETOLOGY OF IOWA.

* BY ALEXANDER G. RUTHVEN

During the summer of 1907, the University of Michigan Museum was enabled, through the generosity of Mr. Bryant Walker, to send a collector to northwestern Iowa for the purpose of investigating the fauna of that region. With the appropriation the writer engaged Mr. Max M. Peet to assist him in the work.

The time spent in the field was from July 1 to September 1, and during this time attention was confined almost exclusively to mammals, birds, reptiles, amphibians, and mollusks. Besides the actual collecting of specimens, notes were made on the habitat relations of the forms, and the stomach contents of the vertebrates were saved in as many instances as possible. The present paper is the second¹ to appear on the results of this expedition.

To Mr. Max M. Peet the museum is under great obligations, for he accompanied the expedition with no other recompense than his expenses, and was untiring in his efforts to make the trip a successful one. Our thanks are also due to Mr. George A. Lincoln, State Game Warden of Iowa, who, after ascertaining the nature of our work, generously extended to us all of the privileges compatible with the law, and to Dr. Leonard Stejneger for comparing our specimens of *Eumeces septentrionalis* with the type in the U. S. National Museum and for verifying our determination of the specimens of *Chrysemys cinerea bellii*.

GENERAL ENVIRONIC CONDITIONS IN THE REGION.

The region explored lies within the adjacent parts of Clay and Palo Alto counties, Iowa. More exactly, collecting was confined to the townships of Riverton, Sioux, Lake, Freeman, and Logan, Clay county, and Lost Island and Highland in Palo Alto county. This area is in the prairie region, so-called, but lies near its western boundary, i. e., where it merges into the higher and more arid Great Plains.²

* University of Michigan Museum.

¹Ruthven, Alexander G., The Faunal Affinities of the Prairie Region of Central North America. Amer. Natur., XLII, pp. 388-393.

²Compare Harvey, LeRoy H., Floral Succession in the Prairie Grass Formation of Southeastern South Dakota. Bot. Gaz., XLVI, p. 81.

³Calvin, Samuel, Physiography of Iowa. The Iowa State Atlas (1904), pp. 258-259.

As is well known, the topography of Iowa is essentially that of an extensive plain. It is described by Calvin³ as follows:

The zero point on the river gauge at Keokuk has an elevation above tide of 477 feet; the elevation of Sibley, the highest important railway station in Iowa, is 1572 feet. It is possible that Ocheyedan mound or some of the morainic protuberances in Osceola County rises 100 feet higher than Sibley, but even then there is less than 1200 feet of difference between the lowest and highest points in the state. One hundred feet is gained at once by ascending the bluffs at Keokuk and passing on to the upland a short distance northwest of the city, so there is left but about 1100 feet as the sum of all the variations in level occurring over the general surface of the great state of Iowa. There are stretches, many miles in extent, so monotonously level that differences in altitude are scarcely perceptible.

While the state as a whole is thus a plain, it does not exhibit the tabular smoothness of the plains area to the westward. This is due to the fact that the region was large glaciated during the Glacial Epoch. From the standpoint of the region under discussion, the last ice-sheet, the Wisconsin, was the most important. It entered the state from the north, and on its retreat left extensive deposits of morainic material in the triangular area which it occupied. Calvin⁴ defines the area glaciated by this ice sheet as follows: "The base of the triangle, where the comparatively narrow ice lobe crossed from Minnesota to Iowa, extends from Worth county to Osceola; the apex is at Des Moines. Through the western part of Worth, Cerro Gordo, Franklin and Hardin counties the edge of the Wisconsin drift overlaps the Iowan one; the apex of the Wisconsin lobe rests at Des Moines on the older Kansan. The Wisconsin area is in general a level ill-drained plain. The traveler may go for scores of miles without seeing a definite drainage trench so much as a foot in width or depth. Saucer-shaped depressions or 'kettle holes,' varying from a rod or two, to an eighth or a quarter of a mile in diameter, are common features of the Wisconsin plain." However, the Wisconsin ice sheet also formed large terminal moraines, and a well defined belt was developed along the western margin of the drift area, extending from Osceola, Dickinson and Emmet counties through eastern Clay and western Palo Alto counties to Guthrie county. In Clay and Palo Alto counties the topography consists of alternating hills and ridges—often 150 to 200 feet high—with intervening depressions containing meadows, lakes, ponds, or swamps according to the depth and drainage. A detailed description of the physiography of these two counties may be found in Volumes XI and XV of the Iowa Geological Survey reports.

The northwestern part is both the driest and coldest in the state. According to Sage⁵ there is an east to west and south to north decrease in

³Loc. cit., pp. 258-259.

⁵Sage, John R., *Climatology of Iowa*. The Iowa State Atlas (1904), pp. 259-260.

precipitation, the nine counties in the northwestern corner having a yearly average of 28.16 inches, 77 per cent of which occurs between April and September. According to the climatological maps published in the Atlas of Iowa, the region studied lies in a belt having a mean annual precipitation of 25-30 inches. Similarly there is a south to north decrease in temperature, the three northern tiers of counties having a mean annual temperature of 44 to 45 degrees. The physiographic and climatic conditions in the state are summarized in an excellent way in the Atlas of Iowa referred to above.

HABITATS.

Owing to the relief there is more diversity in the biotic environments of the region investigated than is usual in the prairie-plains region. The ridges and knobs, varying in height, are separated by small areas of flat or gently rolling prairie, and everywhere are lakes, ponds and sloughs of various sizes. The immediate area studied was on the water-shed between the Missouri and Mississippi river systems, the lakes examined (lying near the Clay-Palo Alto county line) being the source of streams tributary to the different systems. Most of these lakes are drained by the Little Sioux river, which flows approximately through the center of Clay county, emptying into the Missouri, but a few are drained by tributaries of the Des Moines, which flows through Palo Alto county and is a tributary of the Mississippi.

The habitats at the present time may be classified as follows:

UPLAND.

Upland Prairie. Uncultivated areas, covered by the original vegetation of grasses and herbs, are still to be found on some of the ridges. These areas are, however, becoming fewer in number yearly, as more land is placed under cultivation. (Figs. 1 and 2.)

Grain Fields. The greater part of the higher land has, within the past thirty years, been placed under cultivation, and this has been mostly at the expense of the upland prairie areas. (Fig. 3.)

Groves. In many places groves of soft maple, cottonwood, willow, and box-elder have been planted on the uplands. These are so open, however, as to have no appreciable effect on the terrestrial vertebrate fauna, with the exception of the birds, the local distribution of which they are profoundly modifying. (Fig. 4.)

LOWLAND.

Lowland Prairie (Meadows). The low, generally poorly drained areas have in many instances been reserved for hay-land or pasture. In

Some places the original vegetation has been supplanted by tame grasses; in other places it remains undisturbed. The original vegetation consists of a dense growth of tall grasses and herbaceous forms. (Figs. 5 and 8.)

Swamps (Sloughs). The swamps are mostly devoid of trees and filled with a rank growth of grasses and sedges. The vegetation grows principally in clumps and on hummocks composed of roots and decaying vegetation. They are mostly uninfluenced by man, except as they are drained. (Fig. 5.)

Shores of Lakes and Streams (Marginal forests). This habitat supports the only natural timber in the region, and, where undisturbed, there is always a comparatively dense growth along the shores of the streams and larger lakes. The timber zones are, however, much narrower, and the trees more scrubby, than in the southern parts of the state. In most places at the present time this timber has been largely removed. (Fig. 6.)

AQUATIC.

The aquatic life is found in the lakes, ponds, sloughs and streams. The conditions in these habitats are very similar, as the lakes are for the most part shallow and the streams slow-flowing. (Figs. 9, 10, 11.)

AFFINITIES OF THE FAUNA.

Iowa is primarily a prairie state being situated well within the region of central North America that has long been noted for its rich growth of grasses and general lack of forest cover. With the exception of a small area in the northern part, the state lies entirely within the Carolinian area, or eastern humid division of the Upper Austral Zone, of Merriam. This area has been defined by Merriam⁷ as follows:

The Carolinian faunal area occupies the larger part of the Middle States, except the mountains, covering southeastern South Dakota, eastern Nebraska, Kansas, and part of Oklahoma; nearly the whole of Iowa, Missouri, Illinois, Indiana, Ohio, Maryland and Delaware; more than half of West Virginia, Kentucky, Tennessee, and New Jersey, and large areas in Alabama, Georgia, the Carolinas, Virginia, Pennsylvania, New York, Michigan, and southern Ontario. On the Atlantic coast it reaches from near the mouth of Chesapeake Bay to southern Connecticut, and sends narrow arms up the valleys of the Connecticut and Hudson rivers. A little farther west another slender arm is sent northward, following the east shore of Lake Michigan nearly or quite to Grand Traverse Bay.

⁶For detailed notes on the flora of the immediate region see: Macbride, T. H., Iowa Geological Survey, Vol. XL., pp. 499-508; Cratty, R. I., Iowa Geological Survey, Vol. XV, pp. 260-276; Pammel, L. H., The Iowa State Atlas (1904), p. 268.

⁷Merriam, C. Hart, Life Zones and Crop Zones of the United States. U. S. Dept. Agri., Bureau Biol. Surv., Bull. X, pp. 30-31.

It has been shown elsewhere^{*} that the prairie region cannot be merged with the forested region of the states east of Illinois, but that neither, on the other hand, can it be classed with the arid plains. The environic conditions differ from those of the eastern forest region in being more arid and principally characterized by grass associations, and from the arid plains in being less arid and supporting a greater tree growth. Furthermore and in harmony with these conditions, the terrestrial vertebrate fauna consists almost entirely of a mixture of eastern and western forms. In view of these conditions the region must be considered as a transition area.⁹

This point will not be discussed further, but it should be noted that the different elements in the fauna of northwestern Iowa occupy, as a rule, different habitats—the prairie forms being western, and the marginal forest forms eastern types, while in general it is those associated with aquatic conditions that occur in both regions. For instance, it is in the marginal forests along the shores of the streams and lakes (also now in the groves) that one finds the Blue Jay, Baltimore Oriole, Red-headed woodpecker and many other forms characteristic of the forest of eastern North America; it is on the prairie that one finds the prairie Hare, Thirteen-lined *Spermophile*, Franklin *Spermophile*, Western Meadow Lark, Grasshopper Sparrow, Prairie Chicken, Burrowing Owl, and many others, that are distinctly arid plains forms; while it is in the aquatic habitats that one finds the generally widely distributed water birds and amphibious mammals. That the elements in the amphibian-reptile fauna show the same distribution is, I believe, shown by the following table in which an attempt has been made to summarize briefly the local and general distribution of the forms.

^{*}Ruthven, Alexander G., *loc. cit.*

⁹In his former paper on the vertebrate fauna of the prairie region the writer did not attempt to discuss the literature, intending the paper as a contribution of additional data to the subject. To those not familiar with the literature it should be pointed out that Allen (Bull. American Museum of Nat. Hist., IV, p. 231, and The Auk, X, p. 129) has called attention to the fact that the eastern forest and plains faunae intergrade in the prairie region, in the following words: "The transition between the Humid and Arid Provinces is nowhere abrupt; they gradually merge into each other everywhere along their line of junction, as the prairies of the Mississippi Valley gradually become more arid and take on the characteristic aspect of the plains. There is thus here the usual 'transition' belt occurring between contiguous faunal areas." More than this, he has also called attention to the fact that the eastern birds by clinging to the borders of the streams push beyond the eastern forest region into the prairie-plains region (The Auk, X., p. 132).

DISTRIBUTION OF THE AMPHIBIANS AND REPTILES OF NORTHWESTERN IOWA.
 E; occurring principally in the eastern forest region. G; occurring in both the prairie plains and the eastern forest regions.
 W; occurring principally west of the eastern forest region.

Prairie	Groves	Meadows	Sloughs	Shores of Lakes and Streams	Aquatic
Rana pipiens (G)		R. pipiens (G)	R. pipiens (G)	Acris gryllus (G)	A. gryllus (G) (Larvae)
Bufo americanus (G)	B. americanus (G)	B. americanus (G)	B. americanus (G)	R. pipiens (G)	R. pipiens (G) (Larvae)
		Chorophyllus nigritus triseriatus		B. americanus (G)	B. americanus (G) (Larvae)
Ambystoma tigrinum (G)	A. tigrinum (G)	A. tigrinum (G)			C. n. triseriatus (Larvae)
Thamnophis sirtalis parietalis (W)		T. sirtalis parietalis (W)	T. sirtalis parietalis (W)	A. tigrinum (G)	Chrysemys cinerea belli (G)
Thamnophis radix (W)	T. radix (W)	T. radix (W)	T. radix (W)		Chelydra serpentina (G)
Heterodon nasicus (W)					A. tigrinum (G) (Larvae)
Liolopeltis vernalis (G)		L. vernalis (G)			
Eumeces septentrionalis (W)					

It will be apparent from the table that there are exceptions to the above mentioned rule of distribution, as the aquatic *Chrysemys cinerea bellii* occurs principally to the west of the eastern forest region, while *Liopeltis vernalis* is an open habitat form and occurs both in the eastern forest and prairie-plains regions. These cases are exceptions, however, and do not disprove the general statement. It will also be noted that unlike the ornithology there are few decidedly eastern forms in the fauna. I believe that this is due largely to the lack of collections from this habitat, and that when the fauna of the region is more perfectly known more eastern forms will be found in the region and associated with the marginal forest habitats.

However this may be, the table shows that, as far as our present knowledge goes, the reptile-amphibian fauna of northwestern Iowa is composed chiefly of a mixture of those forms that are either of western distribution or occur both in the plains and eastern forest regions and that the majority of the prairie types are western, and the forms closely associated with the aquatic conditions of wide ranging, distribution. This is not other than should be expected for:

1. The habitat conditions in the marginal forest along the streams and lakes most closely resemble those of the eastern forest region, as shown by the fact that the habitats are occupied by plants from the eastern forest.

2. The aquatic and shore habitats of the prairie-plains region are in direct communication with the eastern forest region by means of the tributaries of the Mississippi and Missouri rivers.

3. The prairie (especially the upland) habitats most nearly approach the general conditions on the Great Plains, into which they merge to the westward.

Referring to plants, Harvey¹⁰ has recently stated similar conclusions as follows:

A study of the floristics shows indisputably the commingling of forms of diverse geographical affinity. An unmistakable floristic relation, in many cases specific, exists with a southwestern and southeastern center of post-glacial dispersal. To the east and southeast the deciduous forest type becomes increasingly characteristic, while to the west and southwest the plain or prairie type gradually predominates; the region thus lies in the western border of the tension zone in which migration from these two competing centers of distribution meet. From the southeast the dispersal route has been up the Missouri valley; while the northwestern migration has spread diagonally across natural drainage lines, following the upland plains.

¹⁰Loc. cit., p. 85. The reader is referred to Harvey's paper for a detailed discussion of the factors involved in the distribution of the flora in this region.

LIST OF SPECIES.

1. *Rana pipiens* Schreber.—Leopard Frog. This is the common frog of the region. It was found principally in the sloughs, but was not uncommon in the meadows and even on the prairie.

2. *Bufo americanus* Le Conte.—American Toad. The American toad is of general distribution in the region studied. The eggs are laid in the ponds and sloughs, and soon after the young are hatched they are found in the grassy margins of the sloughs and along the shores of the lakes and ponds. From here many of them work into the meadows and upon the upland prairies. The larger individuals are more abundant in the meadows, in the groves on the uplands, and in the timber zones on the shores of the lakes and streams.

3. *Chorophilus nigrilus triseriatus* (Wied).—Swamp Tree Frog. The northwestern Iowa specimens are referred to this form, as the snout is produced, and the hind limb is short—the heel barely reaching the tympanum when the limb is extended along the side. The species is apparently rare in Clay and Palo Alto counties, and only a single specimen was found by the expedition. This individual was taken in the grass near a small pond on the prairie in Freeman township. The only other individuals observed in this region by the writer was in 1903, when they were found to be not uncommon in a stubble field just north of the locality where the above mentioned specimen was taken.

4. *Acris gryllus* Le Conte.—Cricket Frog. This frog was only found in one locality—in the eastern part of Riverton township, Clay county. Here large numbers were observed on the mud in abandoned channels of the Ocheyedan river. Probably owing to the habitat, most of the specimens are so dark as to obscure all of the markings, but in some the spots on the limbs may be made out, and the usual light stripes on the sides of the head are represented by small markings on the margin of the upper jaw.

5. *Ambystoma tigrinum* (Green).—Tiger Salamander. Two large individuals of this species were found in the cellar of a house in Highland township, Palo Alto county. It is not an uncommon species in the region. The writer has occasionally found it in the abandoned holes of the Spermophiles.

6. *Eumeces septentrionalis* (Baird).—Northern Skink. This specimen is apparently rather rare in Clay and Palo Alto counties. It was found on the uplands and in the higher meadows, but only very rarely. Individuals were observed in Highland township, Palo Alto county, and

in Freeman township, Clay county, and the writer has observed it in the latter locality in previous years. Its principal habitat is undoubtedly the upland prairie.

The coloration of the single specimen obtained is very distinctive (Fig. 7). The pale bluish green of the under surface is continued upward on the sides nearly to the first lateral band. This lateral band is pale bluish, of about one-third the width of a scale, and extends from the ear, just above the insertion of the limbs, upon the tail; it is narrowly and irregularly margined below with black and is itself rather irregular, giving off above some irregular pale marks. The sides are black to the upper lateral stripe, which lies about two scales above the first and extends from above the eye upon the tail. This upper stripe is pale yellow and even narrower than the first, but is more regular. Above the upper lateral band there is a band of black (two half scale rows wide) extending upon the head to the supraocular region. On the median six rows the predominating color is pale brownish olive, as is also the top of the head and the snout. The wide olive dorsal band is irregularly broken up with black which is mostly confined to the edges of the scale rows, forming narrow broken bands the median two of which are the better defined. The chin is pale yellow, and the tail olive with narrow black bands. Cope's¹¹ figures show the scutellation very well. There are 4 supraoculars, 7 supralabials, a postmental, and no postnasal.

The range of the species is as yet very imperfectly known. Originally¹² described from "Minnesota and Nebraska," other specimens have since been listed by Cope from Red River of the North; Sand Hills, Nebraska; Neosho Falls, Kansas; Fort Kearney, Nebraska; and Old Fort Cobb. It seems that this is the first record for Iowa. Hoy¹³ says that in Wisconsin the species is not uncommon as far north as Lake Winnebago, but, in the opinion of the writer, this statement needs verification.

7. *Thamnophis radix* (Baird and Girard).—Racine Garter-snake. This species is the common snake as well as the common garter-snake of the region studied. It is of general distribution, occurring both in the wet and dry habitats. It is most common, however, about the margin of the sloughs. The large number of specimens obtained by this expedition were used in the writer's monograph¹⁴ of the genus, and need not be redescribed. The habits of the specimens have also been summarized

¹¹Cope, E. D., the Crocodilians, Lizards, and Snakes of North America. Rept. U. S. National Museum, 1898, p. 657.

¹²Baird, S. F., Proc. Acad. Nat. Sci. Phila., 1858, p. 256.

¹³Hoy, P. R., Catalogue of the Cold-blooded Vertebrates of Wisconsin, Geol. Surv. Wis., Vol. I, p. 423.

¹⁴Ruthven, Alexander G., The Variations and Genetic Relationships of the Garter Snakes. Bull. 61, U. S. National Museum.

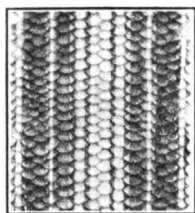


Figure 7. Color pattern of dorsal surface of *Eumeces septentrionalis* (Baird).

in that work. It may be added, however, that, while, as stated in that paper, the pregnant females examined had a maximum number of 25 embryos, two females later kept in captivity each gave birth to 35 young.

8. *Thamnophis sirtalis parietalis* (Say).—Red-sided Garter-snake. This garter-snake is much less common in Clay and Palo Alto counties than is its relative, *T. radix*. Only three specimens (the only ones seen) were secured by the expedition. Of these one was taken on the margin of a slough in Freeman township, Clay county, another in a similar habitat in Highland township, Palo Alto county, and a third near a marshy spot on upland prairie in Highland township, Palo Alto county. In 1903, the writer took three other specimens in Freeman township, Clay county, in a stubble field on high ground. Descriptions of the western Iowa specimens may be found in the revision of the genus cited above.

9. *Liopeltis vernalis* (De Kay).—Green Snake. A single specimen of this snake was taken on the upland prairie in Freeman township, Clay county. The species is apparently rather uncommon in this region, but has been observed by the writer in the meadows of western Palo Alto, and eastern Clay counties. The single specimen obtained has 15 scale rows for the entire length (as is usual in the species), 7 supralabials, 8 infralabials, 74 subcaudals and 141 ventral plates.

10. *Heterodon nasicus* Baird and Girard.—Western Hog-nosed Snake. As has been elsewhere stated,¹⁵ *H. nasicus* is the representative of the genus in Clay and Palo Alto counties. While not uncommon in this region, the species apparently has a very restricted distribution. We found it only on the uplands where the original prairie conditions had not been disturbed. All of the specimens obtained were taken in Freeman township, Clay county, but the writer has observed it in Highland township, Palo Alto county.

The scutellation of the five specimens obtained is quite uniform. The dorsal scale formula is 23-21-19-17, and the supralabials 8, in every specimen. The infralabials are 10 in three specimens, 10-11 in one, and 11-12 in another. In two males the ventrals are 139 and 142, in two females they are 148 and 150. The tails are broken in several so that the number of urosteges cannot be determined. In all of these specimens the plates on the surface of the muzzle are considerably broken up, the accessory scales separating the prefrontals, the internasals from the azygos, and the anterior nasals from the posterior prolongation of the rostral. The color needs no other description than the statement that it is normal. The brownish gray ground color above is relieved by the usual brown

¹⁵Ruthven, Alexander G., Amer. Natur., Vol. XLII, p. 391.

or black spots and the dark and light bands on the head. The center of the belly is black with a few irregular yellow spots. The ends of the gastrosteges are yellow, except that the black of the middle of the belly is prolonged across every second or third scute.

A large female, taken on July 20, laid five eggs on August 4, but died shortly afterward without passing the rest of those in the oviducts. Branson¹⁶ states that he found a full grown meadow-lark in the stomach of one of these snakes. One specimen which we found in a stubble field near a patch of upland prairie had eaten a large toad, and one in captivity ate a large leopard frog. Brous¹⁷ records the finding of individuals of this species attached to the hind leg of the box tortoise (*Terrapene ornata*), which they had partially digested. From this, Brous and Branson both conclude that the snake sometimes attaches itself to the tortoise in this way for the purpose of sucking the blood. This hardly seems probable in view of the known food-habits of the snake. A much more plausible explanation is that the observed snakes had seized the leg in an attempt to swallow the tortoise, and, this being impossible, were unable to release their hold, owing to the fact that the long posterior fangs had become deeply imbedded.

11. *Chrysemys cinerea bellii* (Gray).—Bell's Turtle. This was found to be the common turtle in Clay and Palo Alto counties. It was observed in nearly every slough, pond, lake and stream examined, in both counties.

The specimens taken are typical *bellii*. The ground color of the carapace varies from olive to black. There is usually on the costals a rather prominent yellowish line, and on the costals and vertebrals a number of smaller and more obscure ones. The yellow bands that usually margin the costal and vertebral scutes in *cinerea* are present or absent but when present are narrower or more irregular than in the typical form. A narrow vertebral stripe is present in most of the specimens. The color pattern of the marginals is distinctive: the dark ground color of the upper face is relieved by a prominent median and two fainter lateral bands; these markings are yellowish in color, vertical in position, and the median is, at its outer end, continued laterally to form an outer narrow light border to the marginal. The inferior face of each marginal also possesses a prominent median yellow band (directly below its fellow on the superior face) that extends laterally along the outer edge of the plates, and also tends to be extended at its inner end and connected with its neighbors, restricting the black ground color to a spot. The black

¹⁶Branson, E. B., Snakes of Kansas. Kansas Univ. Sci. Bull., II, p. 377.

¹⁷Brous, H. A., Notes on the Habits of Some Western Snakes. Amer. Nat., XVI, pp. 564-566.

spots thus formed have usually a small yellow center and occasionally other light marks, and are frequently extended below and fused with the adjacent spots, restricting the median yellow band to a bar (as in *marginata*), but this is not the rule. The plastron is pale, and has a large dark patch that occupies the middle and sends out prominent extensions along the transverse sutures.

12. *Chelydra serpentina* (Linnaeus).—Snapping Turtle. The snapping turtle is apparently common in this region, but it is perhaps more characteristic of the larger streams than the bodies of quiet water. However, it was found rather commonly in Virgin Lake, Palo Alto county, and a single individual was taken on land near the outlet of Lost Island Lake, in Clay county. It was quite common in the Occheyedan river, west of Spencer, young turtles being numerous in the ponds in the abandoned channels.



FIG. 1.



FIG. 4.

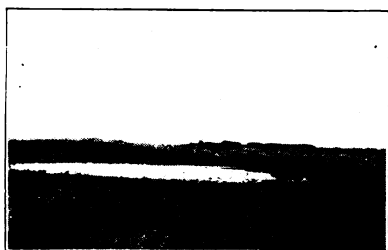


FIG. 2.

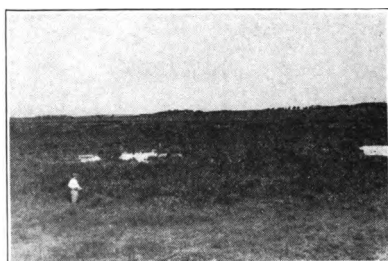


FIG. 5.

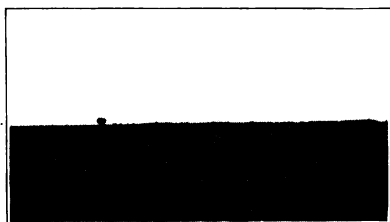


FIG. 3.

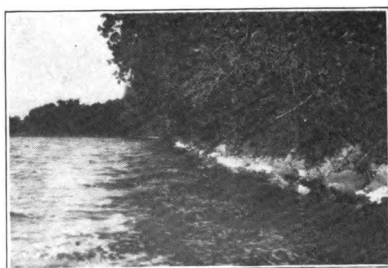


FIG. 6.

HABITATS IN NORTHWESTERN IOWA.

Figure 1. Original prairie in Clay County.

Figure 2. Pond on prairie in Clay County.

Figure 3. Grain field in Clay County.

Figure 4. Grove in Clay County.

Figure 5. Meadow running into a slough in Clay County.

Figure 6. Shore of Elk Lake, Clay County.



Fig. 8. Meadow in Clay County.



Fig. 9. East end of Elbow Lake, Palo Alto County.



Fig. 10. Ocheyedan River at Spencer, Clay County.



Fig. 11. Pond in abandoned channel of Ocheyedan River, Clay County.

AN ANNOTATED CATALOGUE OF THE RECENT MAMMALS OF IOWA.

BY T. VAN HYNING AND FRANK C. PELLETT.

In forming a collection of the fauna of Iowa for the museum of the Historical Department of Iowa, it was early seen that there was no published lists, and but very meager and scattered records of the mammals of the state. It is this condition of affairs which has prompted the compiling of such at this time.

In 1905, Professor Herbert Osborn published a few species of mammals and birds under the title of "The Recently Extinct and Vanishing Animals of Iowa," in the "Annals of Iowa, Volume 6, Number 8." If there be any other lists, the present writers, in the hurried preparation of the one here given, have been unable to locate them.*

The arrangement here, or classification, is practically that as given in Jordan's manual of the vertebrates; eighth edition; and is not claimed to be in accordance with later authors. The list is a preliminary to a complete monograph of the subject which the writers are preparing for future publication, and is intended as a means of drawing information, notes of occurrences in the state, records, criticisms, etc. It is in this that lies the value of the publication at this time, therefore any communications of additional data will be appreciated and considered as sufficient evidence that it has filled its mission. Communications may be addressed to either T. Van Hyning, Polk Boulevard, Des Moines, Iowa, or to F. C. Pellett, Atlantic, Iowa.

Many species are here given that occur in our adjoining states of which we have at this time no records of as occurring in Iowa; but are given with the hopes of gaining sufficient evidence to either establish or permanently eliminate them.

"Extinct," as here used, refers to Iowa only.

*Since writing this paper, nearly a year ago, the writers have discovered a paper, "Notes on the Mammals of Iowa," by J. A. Allen, Proceedings of the Boston Society of Natural History, vol. XIII, 1869-1870. In this paper Mr. Allen lists forty-eight species as inhabiting Iowa at that time.

Order MARSUPIALIA. (The Marsupials.)

Family DIDELPHIDIDIE. (The Opossums.)

Genus DIDELPHIS Linnaeus.

1. *Didelphis virginiana* KERR. Common Opossum.
Southern half of the state.

Order GLIRES. (The Rodents or Gnawers.)

Family LEPORIDAE. (The Hares.)

Genus LEPUS Linnaeus.

2. *Lepus aquaticus* BACHMAN. Water Hare; Swamp Rabbit.
Missouri; Southern Illinois, possibly in Iowa.
3. *Lepus americanus phasonotus* ALLEN. White Rabbit; Varying Hare.
Mr. Pellett has seen specimens taken in Iowa. Minnesota.
4. *Lepus campestris* BACHMAN. White-tailed Jack Rabbit; Prairie Hare.
Sparingly over southern half, and common in northern half of Iowa.
5. *Lepus californicus melanotis* MEARNS. Great Plains Jack Rabbit.
Occurs over Nebraska; records for Missouri and South Dakota; possibly
In Western Iowa.
6. *Lepus floridanus mearnsi* ALLEN. Cotton-tail.
Our most common rabbit.
7. *Lepus floridanus similis* NELSON. Nebraska Cotton-tail.
Minnesota; South Dakota and Nebraska; very likely in north-west part
of Iowa.
8. *Lepus floridanus alacer* BANGS. Oklahoma Cotton-tail.
Missouri and Southern Illinois north to Columbia, Missouri; possibly
in Iowa.

Family ERETHIZONTIDAE. (The American Porcupines.)

Genus ERETHIZON Frederick Cuvier.

9. *Erethizon dorsatus* LINNAEUS. Canada Porcupine.
Comon in Wisconsin; very probably occurred in Iowa earlier.

Family DIPODIDAE. (The Jumping Mice.)

Genus ZAPUS

10. *Zapus hudsonius* ZIMMERMAN. Hudson Bay Jumping Mouse.
"Occurs in Iowa" Preble.
11. *Zapus hudsonius campestris* PREBLE. Prairie Jumping Mouse:
Has been recorded in Iowa.

Family GEOMYIDAE. (The Pouched Gophers.)

Genus GEOMYS Rafinesque.

12. *Geomys bursarius* SHAW. Pocket Gopher; Red Gopher; Prairie Gopher.
All over the state.
- Genus THOMOMYS Maximilian.
13. *Thomomys talpoides* RICHARDSON. Northern Pocket Gopher; Gray Pocket
Gopher.

Occurs in Minnesota, and is common in eastern South Dakota; possibly Iowa.

Family HETEROMYIDAE. (The Pocket Mice.)

Genus PEROGNATHUS Maximilian.

14. *Perognathus hispidus paradoxus* MERRIAM. Kansas Pocket Mouse.
Occurs in Minnesota, South Dakota and Nebraska; probably in north-western Iowa.

Genus NEOTOMA Say.

15. *Neotoma campestris baileyi* MERRIAM. Bailey's Wood Rat.
Common in Eastern Kansas; possibly in Iowa.

Family MURIDAE. (The Mice.)

Genus FIBER Cuvier.

16. *Fiber zibethicus* LINNAEUS. Muskrat.
Occurs all over the state.

Genus SYNAPTOMYS Baird.

17. *Synaptomys cooperi* BAIRD. Lemming Mouse.
Occurs in Minnesota; probably in Iowa.

Genus MICROTUS Schrank.

18. *Microtus pinetorum scalopsoides* AUDUBON and BACHMAN. Mole-like Vole.
Northern form.

Recorded for Illinois; very probably occurs in Iowa.

19. *Microtus minor* MERRIAM. Least Meadow Mouse; Least Upland Vole.
Occurs in Minnesota; probably in Iowa.

20. *Microtus pennsylvanicus* ORD. Meadow Mouse.
"Numerous specimens taken in Iowa" Pellett.

21. *Microtus nemoralis* BAILEY. Woodland Vole.
Recorded for Iowa, Nebraska and Missouri.

22. *Microtus austerus* LE CONTE. Prairie Vole.
Common in Iowa.

Genus EVOTOMYS Coues.

23. *Evotomys gapperi loringi* BAILEY. Red-backed Vole.
Occurs in Minnesota; probably in Iowa.

Genus REITHRODONTOMYS Giglioli.

24. *Reithrodontomys dychei* ALLEN. Western Harvest Mouse.
Common in Kansas; possibly in Iowa.

Genus ORYZOMYS Baird.

25. *Oryzomys palustris* HARLAN. Rice-field Mouse; Prairie Jumping Mouse.

Genus PEROMYSCUS Glogler.

26. *Peromyscus maniculatus* BAIRD and KENNICOTT. Prairie Deer Mouse.
Common over Iowa.

27. *Peromyscus leucopus noveboracensis* FISCHER. Northern white-footed Mouse; Wood Mouse.

Genus ONYCHOMYS Baird.

28. *Onychomys leucogaster* MAXIMILIAN. Missouri Grasshopper Mouse.
Occurs in Nebraska and Missouri; probably Iowa.

Sub-family MURINAE.

Genus *MUS* Linnaeus.

29. *Mus decumanus* PALLAS. Brown Rat; Wharf Rat; Norway Rat. "A cosmopolitan species; introduced into America about 1775" Jordan.
Common all over the state.
30. *Mus musculus* LINNAEUS. Common House Mouse. Cosmopolitan; probably introduced about the same time as the preceding species.
Common all over the state.

Family CASTORIDAE. (The Beavers.)

Genus *CASTOR* Linnaeus.

31. *Castor canadensis* KUHL. American Beaver.
Formerly occurred all over the state; became extinct sometime in the nineties.

Family SCIURIDAE. (The Squirrels.)

Genus *ARCTOMYS* Schreber.

32. *Arctomys monax* LINNAEUS. Woodchuck; Ground Hog; Marmot.
Sparingly over the state.

Genus *SPERMOPHILUS* Cuvier.

33. *Spermophilus franklini* SABINE. Gray Gopher; Scrub Gopher; Prairie Squirrel.
Common all over the state.
34. *Spermophilus tridecemlineatus* MITCHELL. Striped Gopher; Striped Ground Squirrel; Thirteen-lined Squirrel.
Common all over the state.

Genus *CYNOMYS* Rafinesque.

35. *Cynomys ludovicianus* ORD. Prairie Dog.
"Knew of one specimen in Cass County several years ago." Pellett.

Genus *TAMIAS* Illiger.

36. *Tamias striatus* LINNAEUS. Chipmunk; Ground Squirrel.
Sparingly all over the state.
37. *Tamias striatus griseus* MEARNS.
Occurs in Missouri; probably in Iowa.

Genus *SCIURUS* Linnaeus.

38. *Sciurus hudsonicus loquax* BANGS. Southern Red Squirrel.
"Have taken them in Iowa." Pellett.
39. *Sciurus carolinensis* GMELIN. Gray Squirrel; Black Squirrel; Cat Squirrel.
Common over eastern and southeastern Iowa.
40. *Sciurus carolinensis hypophaeus* MERRIAM. Large Gray Squirrel.
Occurs in southern Minnesota; very probably in Iowa.
41. *Sciurus ludovicianus* CUSTUS. Western Fox Squirrel.
Common in Iowa.

Genus *SCIUROPTERUS* Frederick Cuvier.

42. *Sciuropterus volans* LINNAEUS. Common Flying Squirrel.

Occurs all over the state, except western and northwestern parts.

Order INSECTIVORA. (The Insect-eaters.)

Family SCORICIDAE. (The Schrews.)

Genus *SOREX* Linnaeus.

43. *Sorex palustris* RICHARDSON. Water Shrew.

Occurs in Minnesota; Possibly in Iowa.

44. *Sorex richardsoni* BACHMAN.

Occurs in Minnesota; possibly in Iowa.

45. *Sorex personatus* GOEFFREY ST. HILAIRE. Common Shrew.

46. *Sorex hoyi* BAIRD.

Occurs in Wisconsin; possibly in Iowa.

Genus *BLARINA* Gray.

47. *Blarina brevicauda* SAY. Mole Shrew; Short-tailed Shrew.

Common over the state.

48. *Blarina parva* SAY. Least Shrew.

Common over the state.

Family TALPIDAE. (The Moles.)

Genus *SCALOPS* Cuvier.

49. *Scalops aquaticus machrinus* RAFINESQUE. Prairie Mole.

Common all over the state.

Order CHIROPTERA. (The Bats.)

Family VESPERTILIONIDAE. (The Common Bats.)

Genus *MYOTIS* Kaup.

50. *Myotis subulatus* SAY. Say's Bat.

Common all over the state.

51. *Myotis lucifugus* LE CONTE. Little Brown Bat.

52. *Myotis velifer* ALLEN.

Occurs in Missouri; probably Iowa.

53. *Myotis californicus ciliolabrum* MERRIAM.

Occurs in South Dakota; probably in Iowa.

Genus *LASIONYCTERIS* Peters.

54. *Lasionycteris noctivagans* LE CONTE. Silver-haired Bat.

Occurs all over Iowa.

Genus *PIPISTRELLUS* Kaup.

55. *Pipistrellus subflavus* F. CUVIER. Georgian Bat.

Genus *VESPERTILIO* Linnaeus.

56. *Vespertilio fuscus* BEAUVOIS. Brown Rat.

Genus *LASIURUS* Gray.

57. *Lasiurus borealis* MULLER. Red Bat.

58. *Lasiurus cinereus* BEAUVOIS. Hoary Bat.

Order UNGULATA. (The Hoofed Mammals.)

Family CERVIDAE. (The Deer.)

Genus ODOCOILEUS Rafinesque.

59. *Odocoileus americanus* ERXLEBEN. Virginia Deer; Red Deer.
Formerly common all over Iowa; now remains in semi-domesticated herds only; probably became extinct some time in the eighties.
60. *Odocoileus americanus macrouris* RAFINESQUE. White-tailed Deer.
A specimen in the museum of the Historical Department of Iowa taken by Dr. Shaffer, Keokuk; now extinct.
61. *Odocoileus hemionus* RAFINESQUE. Mule Deer.
Occurs in Nebraska; possibly in Iowa formerly.
- Genus CERVUS Linnaeus.
62. *Cervus canadensis* ERXLEBEN. Wapiti; "American Elk."
Formerly common all over Iowa; now remains in semi-domesticated herds only.
- Genus ALCES Gray.

63. *Alces americanus* JARDINE. Moose; True Elk.

The only record known of this species in Iowa is the finding of several teeth in the Boone Mound; supposing they were inhabitants of the territory and were used as food by the pre-historic natives.

Genus RANGIFER Hamilton Smith.

64. *Rangifer caribou* GMELIN. American Reindeer; Woodland Caribou.
Occurs in Wisconsin; probably in Iowa earlier.

Family ANTILOCAPRIDAE. (The Prong Bucks.)

Genus ANTILOCAPRA Ord.

65. *Antilocapra americana* ORD. Prong-horn; Cabree; Rocky Mountain Antelope; Antelope.
Occurs in South Dakota and Nebraska; possibly in Iowa.

Family BOVIDAE. (The Cattle.)

Genus BISON Hamilton Smith.

66. *Bison bison* LINNAEUS. Bison; Buffalo.
Formerly common all over Iowa; now remains in semi-domesticated herds only. Skeletons have been found by the hundreds in old lake beds of the state.

Order FERAEE. (The Flesh-eaters or Carnivora.)

Family PROCYONIDAE. (The Raccoons.)

Genus PROCYON Storr.

67. *Procyon lotor* LINNAEUS. Common Raccoon.
Common all over the state.

Family URSIDAE. (The Bears.)

Genus URSUS Linnaeus.

- 68.
- Ursus americanus*
- PALLAS. Black Bear; Brown Bear; Cinnamon Bear.

Formerly all over the state, now in captivity only. Skulls are occasionally found.

Family MUSTELIDAE. (The Weasels.)

Genus LUTRA Linnaeus.

- 69.
- Lutra canadensis*
- SCHREBER. American Otter.

Formerly common over the state. Became extinct probably in about 1890, as we have no later date.

Genus CHINCHA Lesson.

- 70.
- Chincha hudsonica*
- RICHARDSON. Great Northern Skunk; Northern Plains Skunk.

Rather rare in the state.

- 71.
- Chincha mesomeles avia*
- BANGS. Illinois Skunk.

Occurs in Eastern Iowa.

Genus SPILOGALE Gray.

- 72.
- Spilogale interupta*
- RAFINESQUE. Little Spotted Skunk; "Civet Cat."

Common all over the state.

Genus TAXIDEA Waterhouse.

- 73.
- Taxidea americana*
- BODDAERT. American Badger.

Formerly over Iowa; now extinct.

Genus MUSTELLA Linnaeus.

- 74.
- Mustella americana*
- KERR. Sable; Pine Martin.

Occurs in Minnesota and Wisconsin; probably in Iowa earlier.

- 75.
- Mustella pennantii*
- ERXLEBEN. Pekan; Fisher.

Occurs in Minnesota and Wisconsin; probably in Iowa earlier.

Genus LUTREOLA Wagner.

- 76.
- Lutreola vison*
- SCHREBER. Mink.

Common all over the state.

Genus PUTORIUS Cuvier.

- 77.
- Putorius longicauda*
- BONAPARTE. Long-tailed Weasel.

Common all over the state.

- 78.
- Putorius longicauda spadix*
- BANGS. (A darker form.)

Occurs in Minnesota; possibly in northern Iowa.

Family CANIDAE. (The Dogs.)

Genus VULPES Brisson.

- 79.
- Vulpes pennsylvanicus*
- BODDAERT. Red Fox.

Occurs all over the state; the two next varieties or sub-species intergrade with it.

- 80.
- Vulpes pennsylvanicus decussatus*
- DESMAREST. Cross Fox.

- 81.
- Vulpes pennsylvanicus argentatus*
- SHAW. Silver Fox; Black Fox.

Genus UROCYON Baird.

82. *Urocyon cinereogenteus* MULLER. Gray Fox.

Genus CANIS. Linnaeus.

83. *Canis latrans* SAY. Coyote; Prairie Wolf.

Formerly common all over the state; plentiful yet in some districts.

84. *Canis nubilus* SAY. Timber Wolf; Gray Wolf.

Formerly common in the state; believed to be now extinct.

85. *Canis Nebrascensis* MERRIAM. Prairie Coyote.

Family FELIDAE. (The Cats.)

Genus LYNX Kerr.

86. *Lynx canadensis* DESMAREST. Canada Lynx.

Now extinct.

87. *Lynx rufus* GULDENSTADT. American Wild Cat; Bob Cat.

Formerly over the state; believed to be now extinct.

Genus FELIS Linnaeus.

88. *Felis concolor* LINNAEUS. American Panther; Cougar; Puma; Mountain Lion.

Formerly over the state; now extinct.

THE DEVELOPMENT OF THE SYMPATHETIC NERVOUS SYSTEM IN BIRDS.*

BY ALBERT KUNTZ.

The present investigation of the development of the sympathetic nervous system in birds was undertaken in order to extend the writer's observations on the histogenesis of the sympathetic nervous system in mammals, and to point out certain morphogenetic differences in the development of the sympathetic system in birds and mammals, with a view to their phylogenetic significance.

In a recent paper** the writer has reviewed the literature bearing on the development of the sympathetic nervous system. Therefore, only such references to the literature will be made in this paper as seem to be necessary.

His, Jr. ('97)*** called attention to the fact that in the chick two pairs of sympathetic trunks arise in the course of ontogeny. These he characterized as the "primary" and the "secondary" sympathetic trunks. According to his observations, the cells giving rise to both the primary and the secondary sympathetic trunks are derived exclusively from the spinal ganglia.

My observations on the morphogenesis of the sympathetic trunks in the chick do not differ essentially from those of His, Jr. I find, however, that the cells giving rise to the primary and the secondary sympathetic trunks in the chick, like those giving rise to the sympathetic trunks in mammals, are derived, wholly or in part from the neural tube. From the third to the sixth day of incubation, medullary cells may be observed migrating into the ventral nerve-roots in considerable numbers. With similar cells which wander out from the spinal ganglia, these cells migrate peripherally along the spinal nerves. At a point a little above the level of the aorta, some of these cells deviate from the course of the spinal nerves and wander toward the dorso-lateral surfaces of the aorta where they become aggregated and give rise to the primary sympathetic trunks.

*From the Laboratories of Animal Biology of the State University of Iowa.

**The Development of the Sympathetic Nervous System in Mammals. Jour. Comp. Neurol. and Psychol., Vol. 20, No. 3, pp. 211-253.

***Ueber die Entwicklung des Bauchsympathicus beim Huhnchen und Menschen. Archiv. f. Anat. u. Entw., Supplement, 1897.

About the beginning of the sixth day, the anlagen of the secondary or permanent sympathetic trunks arise in the cervical and in the thoracic region, as ganglionic enlargements on the median sides of the spinal nerves just proximal to the origin of the communicating rami. These ganglionic enlargements are at first independent of each other, but become connected later by longitudinal commissures. There is as yet no evidence of the anlagen of the secondary sympathetic trunks posterior to the thoracic region.

As the secondary sympathetic trunks increase in size and importance, the primary sympathetic trunks decrease. At the close of the sixth day the anlagen of the secondary sympathetic trunks appear throughout the entire length of the body. The primary sympathetic trunks have become less conspicuous and in the thoracic region have completely disappeared.

The prevertebral plexuses are derived directly from the primary sympathetic trunks. About the middle of the fourth day, from the suprarenal bodies posteriorly, cells become separated from the primary sympathetic trunks and, migrating ventrally, become aggregated along the ventro-lateral aspects of the aorta and give rise to the prevertebral plexuses. These cell-aggregates show their greatest development in the sacral region. This condition in birds is obviously correlated with the enormous development of the ganglion of Remak. This ganglion arises toward the close of the fourth day, as an oval cell-column lying in the mesentery just dorsal to the rectum. Its greatest development occurs in the posterior region. It increases in size very rapidly until at the close of the fifth day it has become a large and conspicuous column of closely aggregated cells, with a maximum diameter of about 85 micra. Its diameter decreases anteriorly until it ends in the region of the genital ridges in a slender cellular cord which Remak has called the intestinal nerve (Darmnerv).

The ganglion of Remak was described by Onodi and by His, Jr., but as far as I have been able to learn, the cells composing it have never been traced to their source. My preparations show conclusively that the cells giving rise to this ganglion are derived directly from the anlagen of the hypogastric plexus.

His, Jr. has expressed the opinion that the elements composing the primary sympathetic trunks are resolved into the ganglia and the nerves of the peripheral sympathetic plexuses. In view of the comparatively enormous development of the prevertebral plexuses and the ganglion of Remak, this is obviously the fate of the primary sympathetic trunks in the posterior region of the body. There is no evidence, however, of

peripheral migration of cells from the primary sympathetic trunks in the anterior region. While there may be some migration posteriorly along the primary trunks, it is more probable that most of the cells in the anterior region are withdrawn into the secondary sympathetic trunks.

The vagal sympathetic plexuses; viz., the cardiac plexus and the sympathetic plexuses in the walls of the visceral organs, arise from cells which migrate from the vagus ganglia and the walls of the hind-brain along the fibers of the vagi. While medullary cells are migrating from the neural tube into the ventral roots of the spinal nerves, cells may also be traced from the walls of the hind-brain into the rootlets of the vagus and of the spinal accessory nerves. With similar cells which wander out from the vagus ganglia, these cells migrate peripherally along the vagi. In the thoracic region cells may be traced from the vagus trunks into the walls of the oesophagus where they become aggregated into cell-groups which constitute the anlagen of the myenteric and the submucous plexuses. These observations do not differ materially from the writer's observations on mammalian embryos. In mammalian embryos cells may be traced posteriorly from the anlagen of the myenteric and the submucous plexuses in the walls of the oesophagus and the stomach. These cells obviously give rise to the sympathetic plexuses in the walls of the intestine. In the chick, sympathetic cells cannot be traced posteriorly in the walls of the digestive tube with the same degree of definiteness. It is probable, however, that the cells giving rise to the sympathetic plexuses in the walls of the intestine are derived largely from this source. On the other hand, it is probable, in view of the enormous development of the ganglion of Remak, that in birds many of the cells taking part in the development of the sympathetic plexuses in the posterior region of the intestine are derived directly from this ganglion.

At the bifurcation of the trachea, the vagus trunks bend laterally and ventrally round the bronchi until they come to lie close together along the ventral aspect of the oesophagus. A slender branch of each vagus trunk continues posteriorly from the bifurcation of the trachea along the lateral wall of the oesophagus. In transverse sections through the lungs, fibers accompanied by numerous cells may be seen to bend from these branches into the tissues of the lungs. These cells obviously give rise to the pulmonary plexuses.

About the close of the fifth day, in transverse sections through the heart, cells may be traced ventrally from the vagi toward the dorsal surface of the heart. In later stages these cells become aggregated into distinct groups in the septum of the atria and give rise to the cardiac plexus.

The above observations have shown that in birds, as in mammals, cells migrate peripherally from the neural tube and the cerebro-spinal ganglia, and that some of these cells give rise to the sympathetic nervous system. The cells giving rise to the sympathetic trunks and the prevertebral plexuses, including the ganglion of Remak, migrate peripherally along the spinal nerves, while the cells giving rise to the vagal sympathetic plexuses migrate peripherally along the vagi. The great majority of these migrant cells are the "indifferent" cells of Schaper, while a few cells occasionally are found among them which answer to the description of the "neuroblasts" of Schaper. This I have also shown to be the case in mammals. Mitotic figures occur occasionally along the paths of migration and in the sympathetic anlagen. We are not to suppose, therefore, that all the cells taking part in the development of the sympathetic system actually migrate as such from their sources in the neural tube and the cerebro-spinal ganglia. Doubtless, a goodly number arise by the mitotic division of "indifferent" cells along the course of migration. Inasmuch as these migrant cells are the "indifferent" cells and the "neuroblasts" of Schaper, they are homologous with the cells giving rise to the neurones and the neuroglia cells in the central nervous system. Therefore, the sympathetic system bears a direct genetic relationship to the central nervous system, and the sympathetic neurones are homologues with the efferent and the afferent components of the other functional divisions of the peripheral nervous system.

THE CRANIAL NERVES OF SIREN LACERTINA.

BY H. W. NORRIS.

In this preliminary account of the cranial nerves of *Siren* little reference will be made to the characteristic urodele features, but the descriptions will deal chiefly with those characters that have a special significance in *Siren*.

For our knowledge of the cranial nerves of *Siren* we are indebted to the researches of Fischer (1864), H. H. Wilder (1891) and Druener (1904).

The olfactory nerve in *Siren* is double. A posterior series of rootlets gives rise to a trunk supplying the anterior nasal epithelium and Jacobson's organ; an anterior series of rootlets innervates the posterior nasal epithelium; the two series in origin and distribution are distinct, no observable anastomosing between the two olfactory trunks taking place.

The optic and eye-muscle nerves are of the usual form found in urodele amphibians, all being imperfectly developed in consequence of the rudimentary condition of the eyes.

Of the anastomoses between the fifth and seventh nerves found in other Urodela the following occur in *Siren*: 1. General cutaneous fibers from the gasserian ganglion unite with the ramus ophthalmicus superficialis (lateral line) to form a supra-orbital trunk. 2. An infra-orbital trunk is formed by the union of general cutaneous fibers from the gasserian ganglion with the ramus buccalis VII (lateral line). A branch of the infra-orbital trunk, containing both lateral line and general cutaneous fibers, combines with a branch of the ramus ophthalmicus profundus V (general cutaneous fibers) to form a nerve that sends its lateral line fibers to innervate the anterior portion of the infra-orbital series of neuromasts and its general cutaneous component to form an anastomosis with the ramus palatinus VII. 3. The palatinus-ophthalmicus anastomosis at first sight seems to be peculiar, but is found to fall into line with that described in *Amblystoma* (Coghill) and *Amphiuma* (Norris). 4. The anastomosis between the alveolaris VII and a branch of the ramus mandibularis V, that seems to be characteristic of the Urodela, occurs in *Siren* to the extent only that the two branches in question pass a

short distance in contact with each other, without any exchange of fibers.

From the dorsal edge of the dorsal lateral line ganglion of the seventh nerve there passes posteriorly a branch that anastomoses with the rami supra-temporalis and auricularis X. No such anastomosis has been reported in any other amphibian. It is very suggestive of the condition found in the Cyclostomata, where a branch of the lateral line component of the seventh nerve joins the ninth and tenth nerves.

As has been noticed by previous writers the ramus palatinus and alveolaris VII of Siren arise from the ganglion by a common trunk, from which there is given off posteriorly a nerve called by Wilder the posterior palatine. This latter nerve passes in part to the pharyngeal region, but a part of it anastomoses with the ramus pretrematicus IX forming Jacobson's commissure.

The lateral line constituents of the seventh nerve have in general the characteristic distribution.

The discovery in Siren by Druener of a levator areus hyoidei muscle, which he believes to be innervated by a branch of the ramus jugularis, is confirmed.

The ninth and tenth nerve ganglia are nearly distinct from each other. The ramus communicans carries from the tenth to the seventh nerve general cutaneous fibers only.

Pretrematic rami of five branchial nerves are found, but only three post-trematic rami. The various branches of the tenth nerve show a marked tendency toward an early departure from the main trunk; hence the diffuse character of a large part of the nerve as described and figured by Wilder and others. Motor components of the posttrematic rami of the first and second branchial nerves unite and innervate the ceratohyoideus internus muscle. The ramus intestinalis recurrens is entirely motor. The sensory constituents usually found in this nerve in other Urodela leave the vagus ganglion as a distinct nerve united with other sensory fibers that form the fourth and fifth pretrematic nerves. The name, ramus sensorius recurrens X, is suggested for this nerve after the pretrematic and other pharyngeal branches are given off.

The occurrence of persistent gills in Siren necessitates some special innervation of the branchial region. From the ninth or first branchial nerve a small general cutaneous component goes to the skin over the first branchial arch. From the second branchial nerve (vagus I) the levator branchiae 1 and depressor branchiae 1 and 2 muscles are innervated. It also sends general cutaneous branches to the first and second gills. From the third branchial nerve (vagus II) the levator branchiae 2 and 3 and depressor branchiae 3 muscles are innervated. From the same nerve are given off general cutaneous branches to the third gill.

The hypoglossal nerve is formed from branches of the first and second spinal nerves as Druener has stated.

A comparative study of the morphogenesis of the sympathetic nervous system in birds and mammals reveals certain points of difference which evidently have phylogenetic significance. Two pairs of sympathetic trunks arise in the course of ontogeny in birds, while in mammals a single pair of sympathetic trunks is developed. In the early stages in mammals the prevertebral plexuses show their greatest development in the region of the suprarenals. In the early stages in birds, these plexuses show their greatest development in the sacral region. This character in birds is obviously correlated with the enormous development of the ganglion of Remak which has no counterpart in mammals. The pulmonary plexuses in mammals arise from cells which migrate from the vagi along the walls of the bronchi. In birds cells wander from the slender branches of the vagi, lying along the walls of the oesophagus, directly into the anlagen of the pulmonary plexuses. In mammals the anlagen of the cardiac plexus arise in the angle between the aorta and the pulmonary artery. In birds the anlagen of the cardiac plexus arise in the atrial septum. These morphogenetic differences, doubtless, indicate that the sympathetic system has departed more widely from the original type in birds than in mammals.

A study of the development of the sympathetic system in birds, as well as in mammals, warrants the conclusion that the nervous system is a unit of which the sympathetic system is a part homologous with the other functional divisions. The morphogenetic differences above pointed out in the development of the sympathetic system in birds and mammals obviously indicate specializations in certain directions which have arisen in response to the peculiar conditions of the vegetative functions.

SUMMARY.

1. The primary sympathetic trunks in the chick arise during the fourth day of incubation, as a pair of cell-columns lying along the dorso-lateral surfaces of the aorta. The anlagen of the secondary sympathetic trunks arise about the beginning of the sixth day, as ganglionic enlargements on the median sides of the spinal nerves. These ganglionic enlargements are at first independent of each other, but become connected later by longitudinal commissures. The primary sympathetic trunks reach their maximum development during the course of the sixth day and then give way to the secondary sympathetic trunks. These observations do not differ essentially from those of His, Jr.

2. The prevertebral plexuses arise from cells which migrate ventrally from the primary sympathetic trunks.

3. The ganglion of Remak arises as an oval cell-column lying in the mesentery just dorsal to the rectum. It is composed of cells which migrate ventrally from the hypogastric plexus.

4. Cells migrate from the neural tube and the spinal ganglia along the spinal nerves. Some of these cells deviate from the course of the spinal nerves and give rise to the sympathetic trunks.

5. The vagal sympathetic plexuses: viz., the cardiac plexus and the sympathetic plexuses in the walls of the visceral organs arise from cells which migrate from the hind-brain and the vagus ganglia along the fibers of the vagi. The myenteric and the submucous plexuses in the posterior region of the intestine probably receive some cells from the ganglion of Remak.

6. The cells which migrate from the neural tube and the cerebro-spinal ganglia are the "indifferent" cells and the "neuroblasts" of Schaper. Therefore, they are homologous with the cells giving rise to the neurones and the neuroglia cells in the central nervous system, and the sympathetic neurones are homologous with the efferent and afferent components of the other functional divisions of the peripheral nervous system.

7. Morphogenetic differences obviously indicate that the sympathetic system has departed more widely from the original type in birds than in mammals.

THE DEVELOPMENT OF THE POSTERIOR LYMPH HEARTS OF THE LOGGERHEAD TURTLE.

FRANK A. STROMSTEN.

Recently, in a paper read before the American Society of Zoologists, central section, the writer presented some observations which indicated that the lymphatic system of turtles has an origin more or less independent of the venous system. Since then later investigations on the Chelonian lymphatics confirm and strengthen this view. Even in the development of the posterior lymph hearts, which are generally conceded to be direct derivatives from early redundant embryonic veins, we find that the process is initiated, at least, by the dilation and confluence of mesenchymal spaces.

The posterior lymph hearts are a pair of elliptical or ovoid, pulsating organs found just below the carapace in the post-iliac regions of the turtle, one on each side of the body. They drain the lymph cavities and spaces of the posterior part of the body, and open into the tributaries of the posterior renal advehent veins.

The development of the posterior lymph hearts is initiated by the vacuolation of the subcutaneous mesenchymal tissue of the post-iliac region outside of the muscle plates. Toward the close of the second week of development the spongy tissue thus formed is invaded by capillaries from the first two caudal branches of the postcardinal veins. The confluence of the mesenchymal spaces with each other and with the invading capillaries forms a spongy network of minute channels which collects the lymph from the rapidly growing limbs and tail, and conveys it to the postcardinal veins. Near the middle of the third week, a longitudinal anastomosis of the segmental branches of the postcardinal veins takes place outside of the muscle plates. This forms a large vein on each side of the body which continues forward in the adult, to form the main branch of the posterior renal advehent vein, and backward into the tail as the lateral coccygeal vein. This pair of newly-formed veins now receives all of the lymph from the anlagen of the lymph hearts. The process of the dilation and confluence of the mesenchymal spaces with each other and with the capillaries continues with increasing rapidity throughout the latter part of the third week, forming a number of large

anastomosing spaces, the veno-lymphatic channels. These channels extend parallel with the veins and open into them at two or three points. At first the veno-lymphatic channels contain red blood cells and are indistinguishable from the veins as regards size and general appearance. Later, however, they acquire rather dense walls which contain striated muscle fibres. The cardiac muscle fibres of the lymph hearts are derived from the adjacent muscle plates. The partitions between adjacent veno-lymphatic channels begin to atrophy toward the beginning of the fourth week, so that by the end of the week we find a pair of large sacs with muscular walls, each with a single central cavity.

Thus we see that the posterior lymph hearts of the loggerhead turtle are developed from embryonal capillaries which have been captured and modified by the dilated mesenchymal spaces of the post-iliac regions of the body.

HISTORICAL SKETCH OF EARLY HEALTH REGULATIONS IN IOWA.

BY L. S. ROSS.

The immediate cause for the establishment of rules and regulations to protect the health of a municipality or a state, often is the fear of the introduction of some disease that is foreign to the community. Possibly some other disease is common to a community, its effects, even its ravages are matters of common knowledge, but because of that familiarity its presence is expected; the people are accustomed to it. In reality somewhat of a fatalism with reference to it is established, and no rigorous measures are taken against it for defense or for elimination. It seems we fear the unfamiliar, and accustom ourselves to the presence of the familiar. Our forces are mobilized for defense, first against the foreign foe, then later against the foe at the fireside.

Early attempts toward concerted action against diseases in the colonies of Massachusetts and New York were directed against those that were brought from foreign ports on ship board. In the Territory of Iowa the first lines of defense were likewise thrown out to check the advance of diseases from foreign lands that had effected entry at New Orleans, and were making their way by boat up the Mississippi river, toward the river towns of the Territory. Cholera and ship fever were feared as deadly invaders. Naturally, cholera follows the routes of travel: its ravages may be fearful. The mention of it caused fear and even panic. Tuberculosis and diphtheria and scarlet fever were common, and claimed many more victims but because they were common and were not so spectacular in their effects, the high rate of their mortality was not fully realized. And in fact, at the present time the full import of the prevalence of tuberculosis is realized by a comparative few only. The Asiatic cholera in Iowa, or in the entire country, has been a mere passing incident; tuberculosis is a factor in national development.

The development of the sanitary regulations of the State of Iowa is logically divided into two parts: the one including the time prior to the establishment of the State Board of Health in 1880, the other the time subsequent to that date. The first may be known as the early period and the second as the recent. It is the purpose of this paper to record

some items in the development of the early period, not to give a complete history.

During this time there was no concerted action on the part of the Territory or the young state, and indeed there could be none. Each municipality had to take independent action, and provide regulations that seemed best at the time being. Effective rules and regulations did not spring into being full formed, but they were rather a growth according to the need and the knowledge of the people. Neither the physician nor the layman attached sufficient importance to the common infectious diseases. In the pioneer days men's thought and labor were expended in transforming their uncultivated environment into a place suitable for habitation. That which impressed itself most forcibly as the thing to be done, was the thing that was done. The value of good health rules and regulations was not recognized. In every new community the establishment of sanitary laws has followed after a longer or shorter course of expensive education in which human lives have been unconsciously submitted to accidental experimentation, with a high rate of mortality attending the experiments. Human lives are paid as the price for such education.

The State of Iowa is not old, but its history antedates that of the knowledge of the fundamental principals of sanitation. Here, as elsewhere, it was necessary that the sanitary rules should depend, to a considerable degree, upon a generally accepted belief as to the cause of disease and of its spread. The theories of the more educated then, were similar to the beliefs of many at the present time who give little thought to sanitation. This is indicated by editorials in the leading papers of the day. The more educated popular belief may be inferred from these editorials. Then as now, the value of cleanliness was recognized, but the cleanliness of modern sanitation was unknown.

The Dubuque express and Herald of the date April 19, 1855, says: "It is not enough to ordain that people shall keep their premises clean. * * * Scattering a handful of lime in one infected locality and removing a few shovelfuls of filth from another will but mock the anticipations of the public, and be the means of blinding every person, who with return of warm weather expects the manifestation of cholera and other alarming diseases. * * A state of cleanliness both in person and in every household and on every ones premises is one of the best precautions that can be taken. If taken in time, to prevent the manifestation of disease." The same paper on April 24, says: "Every person of common sense knows that filth breeds disease, and experience proves that in localities where the people are filthy in their habits, there is more sick-

ness and more people die than in localities in the same town or city where the people keep their persons and premises clean. * * * If a woman has not kept her premises clean, there is no reason to exempt even her private room from a scrubbing at the expense of the city. We suggest to the officers that they secure a quantity of disinfesting agents and use them freely as they proceed in their cleaning operations." A quotation in this same paper, the Dubuque Express and Herald, of May 11, 1855, is from the Chicago Times: "The cholera is at our doors. * * * The streets and alleys are in a most deplorable state; they are in a ripe condition, which in the first warm day will bring to a fruitful harvest of disease and death. * * * Now is the time to clean the streets, to sprinkle lime and take precautionary measures."

The Davenport Banner of June 11, 1852, quotes from The Standard, La Salle, Ill., of May, with reference to some deaths among railroad laborers: "* * * Added to this the water was bad, being taken from sloughs that were high; and holding in solution the filth that had been washed from the banks, and was therefore unfit for use. We are told also that some bread they had eaten was made of poor flour with which they had provided themselves on account of its cheapness, and furthermore the day before the sickness broke out among them, a barrel of whiskey had been brought upon the ground of which liberal use was made. The result was some ten or a dozen died soon afterwards, with a sickness resembling cholera morbus."

In the Keokuk Gate City of May 16, 1855, is an editorial headed, "A Deadly Nuisance," demanding that a pond in the heart of the city be done away with: the claim is made that sickness and death of some in the immediate vicinity were due to its existence.

In the same month, the president of the board of health of Keokuk in reply to an editorial criticism in the Keokuk Gate City of the preceding day, May 17, said: "In conclusion we wish to inform your readers that the board of health has no easy task to perform. They meet with many curses and much abuse from persons who can not appreciate the importance of cleanliness about their premises, and this fact should induce more enlightened people to aid them in the performance of their duty, to be a little more charitable in their criticisms."

In the Ottumwa Courier of June 6, 1867, is the following: "Cholera: Our dispatches yesterday inform us that there have been already two cases of Asiatic Cholera in New York, and whether these cases are genuine or not scientific and medical men pretty generally agree that this country is to have another visitation of this most unwelcome guest during the approaching hot summer months, to remain a longer or shorter time as we

may by our negligence or prudence elect. * * * It has been established beyond question, that with proper sanitary precautions this terrible scourge may be robbed of half its terrors if not totally disarmed. Therefore let the authorities proceed to the discharge of their duties: let the streets, alleys, barns, pig pens, privies, and out houses be thoroughly renovated, cleaned up, deodorized and put in order; let the people keep their persons clean and be temperate and careful in their diet." On June 25, in the same paper the following appears: "We have had a vast amount of rain this spring, the back alleys and holes of the city are full of stagnant water, dead cats and other filth, the hot season is upon us with unusual severity, and the probability is that we will be again visited with that unwelcome guest cholera, unless we fortify against it by proper sanitary regulations. Will the city authorities exercise their proper authority in compelling a general cleaning up and deodorizing of the filthy places in the city?" In the same strain the editor on July 23, says: "* * * but there are still many of the out of the way places and alleys that under this blistering sun are becoming death and miasma breeding places of untold filthiness and while they are not so offensive to the eye, because not so public, they are nevertheless just as dangerous to the health of our city as if situated in Front Street."

Two quotations from the Medico-Chirurgical Journal of 1851, give the belief of some physicians concerning the infectiousness of the cholera. In the obituary of Dr. A. F. Bruning appearing in the May number of this Journal the writer says: "A day or two before his attack he expressed his conviction of the infectiousness of the disease and of his liability to an attack from being much in close, filthy apartments." In the June number of the Journal Dr. J. F. Henry, referring to cholera, said: "In my judgment, it depends on a fixed origin, a something from abroad, which may be a *sine quo non* and a local cause sufficient to develop it. The circumstances that constitute that local cause are very well known: they are heat, moisture, and filth, within and without the crowded habitations in which, as a general rule, the disease is most prevalent and most destructive. When really epidemic, the whole population of a city is immersed in this local cause."

A little note on vaccination appearing in the Davenport Banner of the date Feb. 23, 1855, may well be considered by some at the present time: "It is well ascertained that when vaccination takes it is an effectual preventive. It is a simple process, can do no harm and ought for abundant precaution to be repeated. Many persons neglect vaccination too long."

These references are sufficient to show that the people, and evidently the medical profession as well, were especially concerned with the sporadic diseases as cholera and small pox, and not to any great degree with those that were commonly present. They indicate also that the presence of filth was presumably the primary cause of the continuation and spread of these diseases, and perhaps also a factor in their origin.

The evident need of some action to conserve the public health was sufficiently realized in the early days, that the charters of the towns contain provision for health ordinances. In the charter of the town of Fort Des Moines, approved Jan. 18, 1853, is the following in Section 19: "The Town Council is vested with authority to make and establish such by-laws and ordinances as are necessary and proper for the good regulation, safety and health of the town and the citizens thereof * * *." Other sections in the charter of the City of Des Moines as formulated in 1857, have reference to the conduct of the markets. In 1876, the Des Moines city council passed "an ordinance in relation to health," of 32 sections, giving general rules and regulations. The ordinance pertains more directly to the prevention and abatement of nuisances, disposal of garbage, regulation and control of slaughter houses, than to the establishment of quarantine. On Aug. 28, 1878, a health regulation was passed requiring physicians to report contagious diseases to the board of health. When such report was received by the board of health the chairman of the board could have a printed placard placed on the outside of the building or dwelling, or door, or room, of such disease whenever, in his opinion, it was necessary. Any physician neglecting or refusing to perform the duties required by the health ordinance was subject to a fine. Parents or guardians of children were required not to permit the children to attend public or private school after it became known that any of the family had any infectious or contagious disease. Violators of the requirement were subject to a fine. Principals or teachers of private or public schools were required to cause removal of any pupils from school from families where infectious diseases were known to exist, and such pupils were to be refused readmittance until it was known that the premises had been disinfected and the disease eradicated. Violators were subject to a fine. The board of health could adopt rules and regulations for improvement of the sanitary condition of the city.

One of the duties of the council of the city of Davenport, as indicated in Article 5, Section 2, of the Act to Incorporate, approved Feb. 5, 1851, is, "to make regulations to prevent the introduction of contagious diseases into the city, to make quarantine laws for that purpose, and enforce the same within five miles of the city; to establish hospitals and

make regulations for the government of the same; to make regulations to secure the general health of the inhabitants: * * *". In 1852 and 1853 "An ordinance to secure the health of the city, and to prevent nuisances" was passed. The ordinance has to do principally with nuisances, and no reference is made to quarantine regulations. On August 8, 1866, the City Council passed "An Ordinance to secure the Health of the City, providing for a Board of Health and other purposes." In this ordinance the Mayor was empowered to appoint a board of health with the approval of the council, at any time it seemed advisable; the board could be dissolved by the Mayor or the Council when there seemed to be no further reason for its continuance. Meetings were to be held, the first one of any year at the call of the Mayor, and others at either the call of the Mayor or at their own pleasure: it made its own rules of procedure. Section 4 defines the powers and duties of the board as follows: "Said Board of Health shall exercise general supervision over the city of Davenport, with full power to take all steps and use all measures to promote the cleanliness and salubrity thereof, to abate nuisances of every description, on public or private property: to prevent the introduction into the city of malignant, contagious diseases, and to remove or otherwise dispose of any person attacked by any such diseases, and adopt in reference to such person any resolutions, restrictions, or measures deemed advisable: and to establish rules and regulations for the government of the city hospital, and to prevent the introduction or spreading of cholera, ship-fever, small-pox, or other infectious or contagious diseases within the city." The physicians were required to report all cases of ship-fever, cholera, or small-pox they were called upon to attend within the city limits or within five miles of the city, within twelve hours after examination of the patient. Proper precautions were required with reference to the removal of patients with contagious disease to the hospital or to some retired place, or subjecting them to quarantine within their dwellings. Notice of the character of the disease was to be posted on the house or some other suitable place. Small-pox patients were also subjected to isolation under penalty of a fine. Fourteen of the sixteen sections of Art. 2 of the ordinance refer to rules and regulations with reference to boats and the passengers and crews.

In these regulations the specific diseases cholera, ship-fever, and small-pox are named and also "any communicable disease of a fatal or dangerous character." The penalty imposed upon the master of any vessel coming from the south was heavier than the penalty upon the boat master coming from any other direction if quarantine rules were disregarded. This indicates the dread that was felt with reference to

cholera, especially. It appears that the principal cause of fear was to be found in the foreign diseases rather than in those that were endemic. Under date of Sept. 25, 1866, another health ordinance was passed, "To secure the better preservation of the health of the city." In Sec. 4, provision is made for the appointment of a Health Inspector who was to be appointed at the first regular meeting of the council after the first Saturday in November, unless the council should otherwise direct. It was his duty to examine into the sanitary condition of the whole city. He was vested with the requisite power to enforce all the health ordinances of the city. "The office of health inspector was created in view of the fact that the Marshal's time is largely taken up with his general duties, and in view of the further fact that it is not contemplated that a Board of Health will be organized unless in case of threatened or actual epidemics." On Sept. 19, of the same year, 1866, the Council passed "An ordinance to prevent the spread of infectious or contagious diseases, and to preserve the health of the city." This ordinance deals with the destruction or disinfection of bedding and clothing of cholera or small-pox patients.

In 1871 a Board of Health was appointed in Davenport by Mayor Bills because of an epidemic of small-pox. In referring to this board, Dr. A. W. Cantwell in Vol. 6 of the Iowa State Medical Society, says: "Our duty was, or rather seemed to be, only to eradicate contagious diseases; small-pox and cholera being about the only ones the community seemed to fear at that time." Small-pox abated and the board of health was dissolved to be organized again in 1873 in August, when the cholera appeared. In 1879, the board was reorganized and it held regular meetings. Much advance in general sanitary interests was made in that year. In 1880, rules and regulations were framed. This was the first year the physicians were required to report cases of scarlet fever and diphtheria. It was difficult to obtain co-operation on the part of the physicians. A few changes were made in the rules in 1882. In this year in the attempt to enforce the rules, it was necessary to appear in a trial before a police magistrate who, in his finding, declared the board to be an illegal body. An appeal was made to the State Legislature to pass an act empowering cities under special charter to establish boards of health. Such an act was passed by the 19th General Assembly.

In Sec. 13 of the City Charter of the City of Keokuk in the relation of the powers of the City Council it is said: "They shall have power from time to time, to make and publish all such laws and ordinances as to them shall seem necessary to provide for the safety, preserve the health, promote the prosperity, etc." The charter was approved Dec.

13, 1848. In some "Laws amendatory of the charter and concerning city affairs" approved Jan. 22, 1853, provision is made that "The city council of said city shall have power to make regulations to prevent the introduction of paupers, or of contagious diseases, into the city, also to make quarantine laws and enforce the same within the city, and not to exceed four miles beyond the city bounds. * * *". On July 10, 1860, "An ordinance establishing a board of health, was passed." The board was to consist of three physicians, and was to be appointed annually by the city council at their first session in May. The board was to have general supervision over the health of the city and could provide for the removal or safe keeping of persons infected with contagious diseases. Evidently some kind of a board of health was in existence prior to 1860 as the Keokuk Gate City dated May 15, 1855, refers to a report of the board of health. Sec. 21 of "An ordinance concerning misdemeanors," passed July 10, 1860, is to the effect "That the commander or person in charge of any steamboat or other vessel, or any other person whosoever, who shall knowingly bring into the city of Keokuk, any person diseased with the small-pox, cholera, ship-fever or any other communicable or contagious disease, shall be deemed guilty of a misdemeanor."

One of the powers of the city council of Burlington as enumerated in Sec. 12 of the charter, approved June 10, 1845, is one to the effect "that they shall have power from time to time to make and publish all such laws and ordinances as to them shall seem necessary to provide for the safety, the health, promote the prosperity, and improve the morals, order, comfort, and convenience of said city, and the inhabitants thereof." In Sec. 16, the council is given power "to require and compel the abatement and removal of all nuisances within the limits of said city, under such regulations as shall be prescribed by ordinance."

In 1871, or at some time prior to that date, the council of Burlington passed "An ordinance to prevent the introduction and spread of contagious or infectious diseases and to preserve the health of the city." This ordinance bears no date as it appears in Hall's Revised Ordinances of 1871. In 1876, the council passed an ordinance which was adopted May 12, establishing a board of health consisting of the Mayor and City Council. The board was given the usual powers and duties of establishing quarantine, of posting notice of such quarantine, and of requiring all physicians to report all cases of contagious diseases under their care. Also on the same date "An ordinance in relation to dogs" was adopted, of which Section 7 requires the confining or muzzling of dogs whenever ordered to do so by the Mayor's proclamation or by the direction of the council, because of apprehension of hydrophobia. The

duties of the city physician were prescribed in an ordinance of May 13, 1878. He was to advise with the council and was to report contagious diseases and all nuisances to the Sanitary committee.

It appears from the first report of the Clerk of the Burlington board of health, who was also city clerk and ex-officio clerk of the board, that the rules and regulations were of little effect in the period immediately after their adoption. (See mayor's messages 1877-81 p. 84). His report is in part as follows: "The fact that they fall so far short of the actual statistics which the record ought to show is sufficient to raise the question whether or not the present organization of the health department is advisable, and certainly unless more practical and useful results can be attained than have been reached during the past year the expense of books, blanks, labor, and time necessary to collect, classify and compile the statistics of the department will continue to be a waste. The value in a municipal government of this department properly administered need not be argued, nor the importance of complete and accurate vital statistics in the proper administration of a health department. If the department is intended to accomplish no more than the filling of a stagnant pond as occasion may require, that can be easily effected by the sanitary committee without any knowledge of the number or causes of deaths occurring in any locality or during any given period; but if the object sought is a comprehensive and intelligent regulation of the sanitary affairs of the community, the prevention of pestilence and the improvement as far as possible of the general healthfulness of the city, then the compilation and preservation of the vital statistics as ordered by existing ordinances should be more effectually secured, and other measures taken to accomplish those results. That some progress has been made in this direction during the past year is true, and while it is so small that it cannot afford much present satisfaction, it is enough to show a growing sentiment in the community favorable to a continuance of the work."

In the charter of the city of Dubuque, approved Jan. 28, 1857, one of the enumerated powers of the council is, "the abatement of all nuisances in said city": another, "To make regulations to secure the general health of the city:" another, "To make all such ordinances as to them shall seem necessary to provide for the safety, preserve the health, * * * * of said city and the inhabitants thereof." Of the fourteen sections of the revised ordinances, dated 1893, to secure the health of the city, seven relate to the prevention of the introduction of contagious diseases by boats. The diseases named specifically are cholera, yellow

fever, small pox. The health ordinances of Dubuque are in general, similar to those of the other river towns.

There is naturally much similarity in the charters of the towns with reference to the provisions for maintenance of public health, and also much similarity in the ordinances, especially in the river towns. Conditions were practically the same in these towns, with the same means of introduction of the dreaded cholera. The towns were not subject to the same degree of danger as the great sea ports; yet it was more difficult to follow and locate the disease if it once escaped from quarantine or evaded it at New Orleans, than it was to locate it on any infected vessel that might apply for entry at that port. Once escaping from the southern city, it would radiate along the various routes of traffic and travel, the principal line of traffic being the Mississippi river. Careful watch for the disease was kept along the way, not primarily with the object of curing it, but rather to prevent it from landing and to send it on in whatsoever direction it might go. Once landed, then common humanity called for the isolation and care of the patients, as during the epidemic at St. Louis in 1848 and 1850, when many fled from the city and numbers of the sick were put ashore at different places, abandoned to death and to the humanity of strangers. Some old citizens of Ft. Madison can recall the horror of those days when such unfortunates were left near that city. And they revere the memory of heroic and self sacrificing volunteer nurses.

The problem of maintaining the public health in the early day of the river towns was quite different from the problem in the later times, and different from the same problem in the towns back from the river. At the present time the principal value of the old rules and regulations in the various cities with reference to cholera, ship fever and yellow fever lies in their historic interest.

Quite early in the history of Iowa a little attention was given by legislators to the question of local boards of health and a suggestion was offered to the effect that there should be some general regulations concerning the requirements to be made of physicians. On the date Jan. 6, 1844, "Mr. Teas gave notice that he would on some future day ask leave to introduce a bill to regulate the practise of physic, and to prescribe the qualifications of practising physicians."

In the act for the incorporation of cities and towns, going into effect July 4, 1858, the Seventh General Assembly made provision that, "The City Council shall have power to establish a Board of Health," giving it the necessary powers. In 1866, the legislature passed "An act con-

stituting the mayor and council of any incorporated town or city, or the trustees of any township not incorporated, a Board of Health, defining their powers."

The members of the Iowa State Medical Society were not slow to recognize the advisability of having state regulations with reference to health of the people. At the eighteenth annual meeting in 1870, a committee was appointed to draft a bill for compulsory vaccination. The necessity for the creation of a State Board of Health was recognized some time before the necessary action was taken by the legislature. At the 25th annual meeting in 1877, a resolution was adopted memorializing the state legislature to enact a law creating a State Board of Health. In the presidential address in the next year 1878, the establishment of such a board was advocated by Dr. Ristine. At the next meeting of the Society in June, 1879, the mayor of Davenport in his address of welcome suggested that the society should attempt to have a State Board established. In the course of the presidential address at the same meeting Dr. A. M. Carpenter said: "It may not be improper to state in this connection that as chairman of a committee appointed by the president of the American Medical Association, and with the approval of this society, your president respectfully memorialized the legislature to pass a bill such as now graces the legislative acts of Wisconsin, creating a Board of State Medicine, and that the bill was magnanimously pocketed * * *". The committee on the presidential address of Dr. Carpenter reported, "* * * * and in consideration of the importance of its suggestions we respectfully recommend that in-so-far as it refers to state medicine, the whole subject be referred to a special committee consisting of — members whose duty it shall be to present to the state legislature, at its next session, a bill to regulate the practise of medicine and surgery; also to provide for the registration of births and deaths; also to urge upon the General Assembly the importance of the immediate organization of a State Board of Health." At the same meeting, Dr. Carpenter as charman of a committe on State Board of Health, reported: "Your Committee on State Board of Health would respectfully report that they caused to be presented to the last legislature a bill for the establishment of a State Board of Health similar to the Wisconsin law. It met with no encouragement and but little favor in the legislature. Your committee thinks that a little information on the subject published by authority of the society, and for use of the members of the next legislature, and a continued effort on the part of the society will ultimately succeed." (Vol 4, p. 24.) A committee from

the society after conference with the Secretary of the Illinois State Board of Health met with a committee from the Hahnemann Society and drafted a bill to present to the legislature. (Vol. 4, p. 53.) The Eighteenth General Assembly passed an act establishing a State Board of Health in 1880 which took effect on publishing in the papers, Leader, and Register, April 3.

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